Examples of progressive technologies and practices in Nordic Waste Treatment Industries

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Preface

This report deals with established or “Emerging techniques” for Best Available Techniques (BAT) for the Waste Treatment Industries in the Nordic countries:

- Denmark
- Finland
- Faroe Islands
- Greenland
- Iceland
- Norway
- Sweden
- Åland Islands

The report presents and promotes new BAT examples from the Nordic Waste Treatment Industries aimed to be included in an upcoming updated Reference Document (BREF) on Best Available Techniques (BAT) for the Waste Treatment Industries.

The project is carried out by consulting companies in the Ramboll Group and associated consultants in close cooperation with the Nordic BAT-group with Rambøll Danmark A/S as the leading consultant.

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Summary

The Nordic Council of Ministers via its HKP-group (Sustainable Consumption and Production) in cooperation with the NAG-group (Nordic Waste Group) has decided to make a Nordic study concerning good BAT-level techniques to reduce the environmental impact from different Waste Treatment Industries. A working group (BAT-group) on behalf of the NAG-group has been acting as Steering Group for the study.

The aim of this study is to support the future update of the present BREF's from 2006 on Waste Treatment Industries. The practical work has been carried out by the Ramboll Group and associated consultants in close cooperation with the Nordic BAT-group with Rambøll Danmark A/S as leading consultant.

The study made it clear that there are several BAT-level technologies, processes etc. already implemented in the Waste Treatment Industries in the Nordic Countries. The study was carried out in cooperation with these industries. The general objective was to identify a total of approx. 60 industries and select and describe in more detail a total of approx. 30 relevant industries.

Among the total of 57 identified industries 49 are classified as "Established techniques" and 8 are classified as "Emerging techniques." All the objects were screened for environmental and climate impacts and 29 were selected based on level of achieved impact.

1. Introduction

The Reference Document (BREF) from August 2006 on Best Available Techniques (BAT) for the Waste Treatment Industries is to be updated in 2012.

The aim of this Nordic BAT-BREF project is to give the best possible support from the Nordic countries to the update. This includes comments on the existing document and presentation and promotion of new BAT examples from the Nordic Waste Treatment Industries for inclusion in the updated BAT-BREF documents.

1.1 Project objectives

The objectives for this project are to present new or complementary information to the Reference Document (BREF) on Best Available Techniques (BAT) for the Waste Treatment Industries in the Nordic countries aimed for inclusion in the updated BAT-BREF document.

The main objective of this project is to contribute to the upcoming BREF update with the best possible supporting information and examples on low environmental impact technology from the Nordic countries.

Incineration of waste and techniques related to landfills are not included.

Regarding the processing of waste to be used as a fuel, this project only covers such treatment that can be applied to make different types of waste suitable for the fuel quality required by different combustion processes.

Regarding the processing of waste to be landfilled, this project only covers such treatment that can be applied to make different types of waste more suitable for landfilling.

1.2 Comments on present BREF

The existing BREF document (Waste Treatment Industries, August 2006) is compared to BAT examples from the Nordic Waste Treatment Industries and comments are given with the aim of inclusion in the updated BAT-BREF document. Comments are given under the description of each of the Nordic Waste Treatment Industries.

2. Presentation of BAT examples

In this project 57 Nordic examples of technologies and practices in Nordic Waste Treatment Industries were identified and screened for achieved climate and environmental benefits and 29 examples were investigated and described in more detail in this report.

2.1 Criteria for selection of the objects

Criteria for selection of Nordic examples on technologies and practices are that the object:

- is situated in a Nordic country
- is new and can be included in the existing BREF
- is found in the existing BREF, but has a new application
- is new but is not found in the existing BREF, but technology is applied
- is included in the existing BREF as “Emerging techniques”, and the technology is now applied
- is under development and can be listed as “Emerging techniques”

2.2 Selection of the objects

In the Nordic countries, all Waste Treatment Industries with an environmental permit are identified and evaluated according to the selection criteria. Also “Emerging techniques” under development or without an environmental permit are identified and evaluated.

2.2.1 Denmark

Source of information: Danish Environmental Protection Agency DEPA (Miljøstyrelsen), DAKOFA, Confederation of Danish Industries (Dansk Industri), Ramboll Denmark A/S.

- Identified industries: 737

2.2.2 Faroe Islands

Source of information: The Environment Agency, Faroe Islands.

- Identified industries: 7

2.2.3 Finland

Source of information: Finnish Solid Waste Association, Association of Environmental Enterprises, Finnish Biogas Association, Ramboll Finland Oy.

- Identified industries: 85

2.2.4 Greenland

Source of information: Ministry of Domestic Affairs, Nature and Environment, Ramboll Greenland A/S.

- Identified industries: 0

2.2.5 Iceland

Source of information: Umhverfisstofnun, Matis, relevant industries.

- Identified industries: 86

2.2.6 Norway

Sources of information: Ramboll Norway AS, Climate and Pollution Agency (Klima- og forurensningsdirektoratet – Klif), Waste Management Norway (Avfall Norge), Eniro Norge AS, The Brønnøysund Register Center (Brønnøysundregistrene), Statistics Norway (Statistisk sentralbyrå), Peterson Linerboard AS, BIR Privat AS, Cambi AS, Remiks Miljøpark AS, Ecopro AS, Mjøsanlegget AS, Norsk Glassgjenvinning AS, IVAR IKS, Lindum AS, WEEE Recycling AS, Titech AS, Cambi AS.

- Identified industries: 200

2.2.7 Sweden

Source of information: Ramböll Sverige AB, Avfall Sverige, Energigas Sverige, Svenskt vatten AB.

- Identified industries: 258

2.2.8 Åland Islands

Source of information: Ramböll Sverige AB.

- Identified industries: 1

3. Reference of the objects

In this project 57 Nordic examples of technologies and practices in Nordic waste treatment industries were identified and screened for achieved climate and environmental benefits and 29 examples were investigated and described in more detail in the report.

Number of waste treatment industries in each country divided into treatment methods

In the table below the total number (57) of treatment industries identified for each country divided into treatment methods are listed.

Initiative	Biological treatment		Physico chemical treatment		Other treatment operations		Treatment operations for energy recovery		Treatment operations for disposal	
Country	Established techniques	Emerging techniques	Established techniques	Emerging techniques	Established techniques	Emerging techniques	Established techniques	Emerging techniques	Established techniques	Emerging techniques
Denmark (16)	4		7	1			1	3		
Finland (17)	5	1			6	1	3	1		
Greenland (0)										
Iceland (3)					3	(0)				
Norway (10)	4		6							
Sweden (10)							8		1	1
Faroe Islands (0)										
Aland Islands (1)							1			

The following objects were identified:

- Ecopro AS, Norway
- IVAR IKS, Norway
- Lindum AS, Norway
- Mjøsanlegget AS, Norway
- Biovækst, Denmark
- KomTek Miljø A/S, Denmark
- Odense Nord Miljøcenter, Denmark
- CompSoil Danmark Aps, Denmark
- Envor Biotech Oy, Finland
- VamBio Oy, Finland
- Pirkanmaan Jätehuolto Oy, Finland
- Biovakka Suomi Oy, Finland
- Lakeuden Etappi Oy, Finland
- St1 Biofuels Oy, Finland
- Ecopro AS, Norway
- Glasitt AS, Norway

- Gypsum Recycling A/S, Denmark
- Peterson Linerboard AS, Norway
- Remiks Miljøpark AS, Norway
- TH Paulsen AS, Norway
- WEEE Recycling AS, Norway
- Gamle Mursten, Denmark
- Genan A/S, Denmark
- Shark Solutions A/S, Denmark
- Novopan Træindustri A/S, Denmark
- Kommunekemi A/S, Denmark
- Frandsen Industri, Denmark
- BlackCarbon A/S, Denmark
- Hedinn hf., Iceland
- Akkuser Oy, Finland
- Cool Finland Oy, Finland
- Isfelag Vestmannaeyja, Iceland
- L&T Recoil Oy, Finland
- Muovix Oy, Finland
- Primex ehf, Iceland
- Onni Forsell Oy, Finland
- Ekokem Oy Ab, Finland
- ZenRobotics Ltd, Finland
- DAKA Biodiesel Production, Denmark
- NSR biogas plant in Helsingborg, Sweden
- Domsjö fabriker, Sweden
- Henriksdal waste water treatment plant, Sweden
- Linköping biogas plant, Sweden
- Norrmejerier biogas plant, Sweden
- Uppsala biogas plant, Sweden
- Västerås biogas plant
- Örebro biomethane plant, Sweden
- ÅCA, Åland
- EwaPower Ab Oy, Finland
- Lassila & Tikanoja Oy, Finland
- Oy Stormossen Ab, Finland
- REnescience, Denmark
- SCF Technologies, Denmark
- Inbicon A/S, Denmark
- Ekoport Oy, Finland
- Ragnsells Heljestorp AB, Sweden
- Smedlund Miljösystem AB, Sweden

Of these 57 objects the following 29 were further investigated and described in more detail:

- Ecopro AS, Norway
- BioVækst A/S, Denmark
- KomTek Miljø A/S, Denmark
- Odense Nord Miljøcenter, Denmark
- Envor Biotech Oy, Finland
- St1 Biofuels Oy, Finland
- Ecopro AS, Norway
- Gypsum Recycling International A/S, Denmark
- Peterson Linerboard AS, Norway
- TH Paulsen AS, Norway
- Gamle Mursten ApS. (Old Clean Bricks ApS.), Denmark
- Genan A/S, Denmark
- Novopan Træindustri A/S, Denmark
- Hedinn, Iceland
- Akkuser Ltd, Finland
- Cool Finland Oy, Finland
- Isfelagid Vestmannaeyja, Iceland
- L&T Recoil, Finland
- Muovix Oy, Finland
- Primex, Iceland
- Onni Forsell Oy, Finland
- ZenRobotics Ltd., Finland
- DAKA Biodiesel Production a.m.b.a., Denmark
- NSR AB, Sweden
- Domsjö Fabriker AB, Sweden
- Svensk Biogas i Linköping AB, Sweden
- Ekoport Oy, Finland
- Norrmejerier, Sweden
- Smedlund miljösystem AB, Sweden

4. Description of the objects

This chapter sets out techniques considered generally to have a potential for achieving a high level of environmental protection in the industries within the scope of the document. Management systems, process-integrated techniques and end-of-pipe measures are included, but a certain amount of overlap exists between these three measures.

Prevention, control, minimisation and recycling procedures are considered as well as the recovery of materials and energy.

Techniques may be presented separately or as combinations to achieve the objectives of the IPPC Directive. Annex IV to this Directive lists a number of general considerations to be taken into account when determining BAT, and techniques within this chapter will address one or more of these considerations. As far as possible, a standard structure is used to outline each technique, to enable comparison of techniques and an objective assessment against the definition of BAT given in the IPPC Directive.

This chapter does not represent an exhaustive list of techniques and others may exist or be developed which may be equally valid within the framework of IPPC and BAT.

The standard structure used to outline each technique is shown below.

Type of information considered	Type of information included
Description	Brief technical description using, as appropriate, pictures, diagrams and flow sheets
Achieved environmental benefits	Main potential environmental benefits to be gained through implementing the technique (including energy, water, raw material savings, as well as production yield increases, energy efficiency, etc.).
Cross-media effects	<p>Potential environmental side effects and disadvantages to other media due to implementation of the technique, including details of the environmental effects of the technique in comparison with others (advantages and disadvantages supported by data if available) in order to assess the impact of the technique on the environment as a whole. This may include issues such as:</p> <ul style="list-style-type: none"> Consumption of raw materials and water Energy consumption and contribution to climate change Stratospheric ozone depletion potential Photochemical ozone creation potential Acidification resulting from emissions to air Particulate matter in ambient air (including microparticles and metals) Eutrophication of land and waters resulting from emissions to air or water Oxygen depletion potential in water Persistent/toxic/bioaccumulable components in water or to land (including metals) Creation or reduction of (waste) residues Noise and/or odour Risk of accidents
Operational data	Actual performance data (including reference conditions, monitoring periods and monitoring methods) on emission levels, consumption levels (raw materials, water, energy) and amounts of waste generated. Any other useful information on how to operate, maintain and control the technique.
Applicability	Indication of the type of plants or processes in which the technique may or cannot be applied as well as constraints to implementation in certain cases, considering, e.g. plant age (new or existing), factors involved in retrofitting (e.g. space availability), plant size (large or small), techniques already installed and type or quality of product.
Economics	Information on costs (investment and operating) and any possible savings (e.g. reduced raw material or energy consumption, waste charges) or revenues including details on how these have been calculated/estimated. Economic information relevant to new establishment and retrofitting of existing installations will be included. This should allow for identifying, where possible, the overall economic impact of the technique.
Driving force for implementation	Specific local conditions, requirements (e.g. legislation, safety measures) or non-environmental triggers (e.g. increased yield, improved product quality) which have driven or stimulated the implementation of the technique to date.
Example plants	Reference to the plant(s) where the technique has been implemented and from which information has been collected and used in writing the section. Indication of the degree to which the technique is in use in Europe or worldwide.
Reference literature	Literature or other reference material (e.g. books, reports, studies, websites) that was used in writing the section and that contains more detailed information on the technique.

OBJECT	PAGE	EMERG	Title of the Object	Reference plant	BREF position
3.1.1.1	29	E	Biological treatment of sludge and organic waste from households and professionals by Cambi process	Ecopro AS, Norway	Not included
3.1.1.2	31		Anaerobic digestion of source separated household waste, organic waste from industries and sludge producing biogas and fertiliser/soil conditioning agent.	BioVækst A/S, Denmark	2.2.1
3.1.1.3	34		Composting of organic waste from households, Waste Water Treatment, garden and park maintenance, food industries and farming	KomTek Miljø A/S, Denmark	Not included
3.1.1.4	37		Composting of organic waste from Waste Water Treatment and garden and park maintenance	Odense Nord Miljøcenter, Denmark	Not included
3.1.1.5	39		Anaerobic digestion of source separated biodegradable household waste, bio-waste from industries and sludge producing biogas and soil improving products/compost	Envor Biotech Oy, Finland	2.2.1
3.1.2.1	42		Production of bioethanol from bio-wastes using the Bionolix™ technology.	St1 Biofuels Oy, Finland	2.5.2
3.2.1.1	44		Physico chemical treatment of sludge and organic waste from households and professionals by Cambi process	Ecopro AS, Norway	Not included
3.2.1.2	46		Physical and mechanical treatment of used corrugated cardboard recycling it into new corrugated cardboard, paper bags, fish boxes and drinking cups	Peterson Linerboard AS, Norway	Not included
3.2.1.3	48		Fully automatic sorting of mixed paper and cardboard waste by Titech technology.	TH Paulsen AS, Norway	Not included
3.2.1.4	49		Recycling of gypsum from construction and demolition waste (gypsum boards).	Gypsum Recycling International A/S, Denmark	2.3.3.3
3.2.1.5	51		Cleaning and reuse of old tile bricks.	Gamle Mursten ApS. (Old Clean Bricks ApS.), Denmark	2.3.3.3
3.2.1.6	53		Recycling of spent tyres from vehicles.	Genan A/S, Denmark	2.3.3.3
3.2.1.7	56		Processing of “clean” wood waste to be used as a raw material for the production of chip boards.	Novopan Træindustri A/S, Denmark	2.3.3.3
3.3.1.1	58		Recycling of batteries and accumulators using Dry Technology™.	Akkuser Ltd, Finland	Not listed, but could be included in 2.4 Treatments applied mainly to recover materials from waste
3.3.1.2	61		Recycling of refrigeration equipment containing CFC-compounds.	Cool Finland Oy, Finland	2.4
3.3.1.3	63		Small-scale factory for production of fish meals and fish oils from fish by-products (defined as waste, if not treated for use).	Hedinn, Iceland	Not included
3.3.1.4	65		Fish processing plant – Recovery of by-products from process water.	Isfelagid Vestmannaeyja, Iceland	Not included
3.3.1.5	68		Re-refining of used lubricating oils into new base oils by using fractionation and hydrofinishing technology.	L&T Recoil, Finland	2.4.1
3.3.1.6	70		Recycling of plastic waste into plastic profiles for construction purposes.	Muovix Oy, Finland	2.4
3.3.1.7	72		Recycling of barrels and IBC packages.	Onni Forsell Oy, Finland	2.4

OBJECT	PAGE	EMERG	Title of the Object	Reference plant	BREF position
3.3.1.8	74		Chitosan processing plant.	Primex, Iceland	-
3.3.2.1	78	E	A robotic waste sorting system.	ZenRobotics Ltd., Finland	2.4
3.4.1.1	81		Processing waste products from the agricultural sector (animal bi-products) producing biodiesel.	DAKA Biodiesel Production a.m.b.a., Denmark	Pos. 2.5.2.5 (currently only vegetable waste).
3.4.1.2	84		The largest producer of biogas in Sweden.	Domsjö Fabriker AB, Sweden	2.2.1
3.4.1.3	86		Use whey to produce biogas	Norrmejerier, Sweden	2.2.1
3.4.1.4	88		Production of biogas and certified manure	NSR AB, Sweden	2.2.1
3.4.1.5	90		Production of biogas	Svensk Biogas i Linköping AB, Sweden	2.2.1
3.4.2.1	92	E	The production of diesel oil from REF feedstock by using the KDV technology	Ekoport OY, Keilasatama	2.5.2
3.5.2.1	94	E	Dry conservation of organic waste.	Smedlund miljösystem AB, Sweden	Not included

4.1 Biological treatment

4.1.1 *Objects in the BREF – Established techniques*

Ecopro AS, Norway

Description of the technique. The facility receives and treats organic waste from households and sewage sludge. The plant capacity of input material is approx. 30,000 tonnes/year. The material is pretreated in an autogenous mill. The grinded material is mixed with reject water from dewatering of the treated product. In the mixing tank heavy material (sand, bones) is removed from the bottom and light material (wood, plastic) is removed from the top. The mixed liquid flow is combined with slurried waste (WW sludge) in a pulper where the fractions are mixed and heated as a preparation for thermal hydrolysis (Cambi process).

After pulping, the material is transferred to the hydrolysis reactor, where steam is used to increase both pressure and temperature. The temperature is kept at around 165–170°C. Excess steam is used for heating in the pulper. Between the hydrolysis reactor and the anaerobic reactor is a flash tank that acts as a buffer. Excess steam from the flash tank is also used for heating in the pulper. The thermal hydrolysis step serves two purposes; it removes pathogens and weeds (hygienisation), but it also increases the biological yield in the anaerobic reactor by breaking down larger organic particles to smaller and more easily digestible particles. Compared with pasteurization (conventional hygienisation), the Cambi process can achieve a higher degree of sanitization.

The thermal hydrolysis is followed by anaerobic digestion. The temperature is kept at 37–40°C (mesophilic range). This process produces biogas and residual biomass. The residual biomass is screened and dewatered in a centrifuge. The end product is used for soil improvement in agriculture. The biogas is burned in a gas engine for electricity generation.

Applicability

The method is based on a well known process that turns wet organic waste into biogas and a soil improvement product. The biogas is used for energy generation, ensuring that the plant is a net producer of energy.

Environmental impact and benefits, energy efficiency

Energy is consumed for pre-treatment and heating of the anaerobic reactors. The biogas produced is used for electricity generation, which exceeds energy consumption, so the process is a net producer of energy.

Cross-media effects

Converts waste organic materials into valuable soil improvement products to be used in agriculture etc, and produces biogas which is burned for electricity generation.

Driving force in implementation

Environmental benefits, the need to prevent spreading of plant and animal diseases, energy generation, reduction of landfill and/or incineration of waste.

Economics

Income from receiving organic material (treatment fee), income from selling soil improvement products and income from energy generation.

Reference plant

Ecopro AS, Norway

Position in the present BREF

Not included

4.1.2 BioVækst A/S, Denmark**Description of the plant and of the technique**

BioVækst A/S is a company jointly established by the private company Solum A/S and the public waste management company Kara/Noveren. The company has established a combined biogas and composting facility at Audebo landfill facility in Holbæk.

The facility uses input materials in the form of remains of organic materials such as organic household waste, kitchen waste from institutions etc., organic remains from industrial production of food for human consumption, vegetable based oils and fat, sewage sludge and organic remains from agriculture. The outputs besides energy in the form of biogas are different types of compost products depending on the input. The present input capacity of the facility is 18,000 tonnes/year.

The design of the facility is based on the Aikan system developed by Solum, which is a two-phase batch treatment system combining anaerobic digestion and composting comprising the following:

- The waste is received and its quality is controlled visually
- Waste bags are opened. A mixer operated by a tractor is used to break up the waste. The slowly rotating blades open the bags and break up organic compounds into smaller particles, simultaneously

ensuring that incorrectly sorted waste such as metal, glass, nappies and plastic do not affect the process. Waste bags are opened gently without shredding them to smaller pieces or breaking glass etc.

- Depending on the amount of impurities the waste is either sorted on a drum screen (80 mm) or mixed directly with wood structure materials. The sorted waste is then shredded into a smaller fraction, and the structural material that allows for the aeration and drainage of the waste mass is added
- The waste mass (raw material) is then mixed thoroughly in the mixer and then transferred to a process module via a conveyor belt mounted on the back of the mixer
- The mixture of waste and structural material is loaded into fully closed process modules in which the entire active AD and compost process takes place
- When the process module is full, it is closed with an air-tight door
- Anaerobically digested liquid material from the biogas reactor tank is added through a system of pipes
- To achieve the fastest possible process time the liquid, which is formed during the process, is collected, reheated and re-circulated in the process module
- Biogas is continuously produced in a separate reactor tank. Biogas is combusted in a gas turbine, which produces electricity and heat. The biogas can also be refined for fuel. The digestion process runs from two to four weeks – depending of the gas potential of the concrete waste type
- After the satisfactory conversion of the waste, the waste mass is drained of percolate and the composting process begins
- During the composting process, the entire waste mass is heated to a minimum of 70°C for at least 1 hour, thus eliminating disease-causing organisms. The compost can then be used for agricultural purposes without hygienic restrictions
- After the active process, the door is opened and the compost is either sorted directly after emptying the module – or matured for a period – depending on the field of use. In the sorting plastics are removed by a windscreen and metals are removed with a magnetic separator. Screening takes place on a 10–15 mm sieve size

Applicability

The method is based on well known processes and the size of the plant can be adapted continuously according to needs by supplementing with new modules. The use of a batch process system enables the use of different types of input materials.

Environmental impact and benefits, energy efficiency

The process takes place in a closed system significantly reducing impacts on the outside environment.

The process is a net generator of energy in the form of biogas. On average more than 100 m³ (70% methane) is produced from 1 tonne of food waste. A further output is 350 kg of compost, which can be used as a soil conditioner and a fertilizer.

Cross-media effects

The produced biogas substitutes fossil energy resources for heating and fuel purposes thereby reducing CO₂ emissions.

Driving force in implementation

Environmental benefits, reduction of CO₂ emissions, reduction of land-filling of waste.

Economics

Income from receiving raw materials (treatment fee) and from sale of biogas and possible compost products.

Reference plant

BioVækst A/S, Denmark

Position in the present BREF

Pos. 2.2.1.

4.1.3 KomTek Miljø A/S, Denmark**Description of the plant and of the technique**

The facility receives and treats organic waste from households, sewage sludge, garden and park waste and organic waste from food industry and farming. The capacity of the plant is approx. 70,000 tonnes/year of input material.

Garden and park waste is shredded and mixed with the other organic waste components before being placed in windrows. During the windrow composting process the temperature inside the windrows will reach minimum 55°C for a period of minimum 2 weeks, resulting in a compost free from weeds and pathogens. The initial period of composting of 4 to 6 weeks takes place indoors in order to optimize the composting processes by stabilizing temperature and humidity.

Due to controlled exhaust through hoods covering the top of the windrows control of ammonia, odour and other emissions is improved.

The exhaust air is treated by air washer and biological treatment to eliminate ammonia and reduce odours. Ammonia is collected in a solution of sulphuric acid, to be recycled as fertilizer. The maturing process of the composting (1.5 to 3 years) takes place outside in stock piles. During the composting and maturing periods the organic material will be turned at regular intervals (2 to 3 times a week in the initial period of composting, reduced to once a week in the final stages of maturing). If necessary, water will be added to the organic material.

The matured compost is sorted by size and used directly as soil improvement/topsoil in agriculture or gardening, or it may be mixed with other components for production of various specialized soil improvement products, topsoils or growth media to be used in agriculture, gardening and sport courses etc.

Those parts of the park and garden waste that are most suitable for firewood are shredded and sold as chipwood to district heating plants etc.

Most machines used are mobile equipment such as shredder, windrow turning machine, drum sieves, frontloader etc. Sorting is done by stationary, high capacity, multi sorting equipment.

Applicability

The method is based on well known processes and the size of the plant can be adapted continuously according to needs by adding new windrows.

The exhaust systems through the covering hoods of the windrows and the air cleaning systems are developed by the company itself and may be regarded as “state of the art” when it comes to control of exhaust air from windrow composting plants.

Environmental impact and benefits, energy efficiency

The odour impact on the surroundings can be substantial if the composting process is not carefully monitored in order to secure a sufficient oxygen content of the organic material, especially during the initial composting period.

Emissions of ammonia are generally below 5 ppm and only in very short periods exceed 10 ppm. It is fully controlled by the wet scrubber system. Odour from exhaust is a constant challenge but is now reduced to between 5 and 10 LE/m³ (Danish Odour Units/m³) at the nearest neighbours. Due to optimization of the air cleaning systems 5 LE/m³ is expected to be reached in spring 2011.

As it is not possible to recover the heat generated in the composting process, the process is a net consumer of energy to run machinery etc. Quite large amounts of low temperature energy are dismissed by the

exhaust air, and the possibilities for recovering/utilizing this energy are continuously investigated.

Composting of organic materials reduces the need for other disposal options such as landfilling and incineration. Instead valuable nutrients etc. are recycled in the produced soil improvement product, and 10–20% of the organic materials are accumulated in the soil as fixed carbon.

Use of fuel (diesel oil) for the mobile equipment is between 2.7 and 3.2 litres/tonne of organic material received. Use of electricity to operate the ventilation equipment in the indoor composting facility and sorting equipment is between 5 and 10 kWh/tonne of organic material received.

Cross-media effects

Converts waste organic materials into valuable soil improvement products to be used in agriculture etc.

Driving force in implementation

Environmental benefits: Optimization of soil quality, reduction of land-filling and incineration of waste, accumulating carbon (carbon dioxide) in the soil and hereby reducing greenhouse gases.

Economics

Income from reception of organic materials (treatment fee) and from sale of compost products.

Reference plant

KomTek Miljø A/S, Denmark

Position in the present BREF

Not included

4.1.4 Odense Nord Miljøcenter, Denmark

Description of the plant and of the technique

The facility receives and treats organic waste in the form of sewage sludge and garden and park waste. The capacity of the plant is approx. 70,000 tonnes/year of input material. The facility is owned by Odense Municipality and established in combination with a large municipal landfill.

Garden and park waste is shredded and mixed with the other organic waste components before being placed in windrows in an open area. During the windrow composting process the temperature inside the windrows will reach up to 70°C during a period of minimum 2 weeks thereby generating a compost free from weeds and phatogens. The ini-

tial composting period (approx. 8 weeks) with high activity is followed by a longer (3–4 months) composting period with low activity. During the composting period the organic material will be turned over at regular intervals (based on temperature measurements) and aerated. If necessary, water will be added to the organic material. Following the composting period maturing of the compost will take place for a period of up to one year.

The matured compost will be sorted and used for production of various soil improvement products to be used in agriculture or private gardens.

Machinery used is mobile equipment such as shredder, windrow turning machine, drum sieves, frontloader etc.

Applicability

The method is based on well known processes and the size of the plant can be adapted continuously according to needs by adding new windrows.

Environmental impact and benefits, energy efficiency

The odour impact on the surroundings can be substantial if the composting process is not carefully monitored in order to secure a sufficient oxygen content of the organic material, especially during the initial composting period and when sewage sludge is used as an input material. The composting process is a net consumer of energy to run machinery etc.

Composting of organic materials reduces the need for other disposal options such as landfilling and incineration. Instead valuable nutrients etc. are recycled in the produced soil improvement product.

Use of fuel (diesel oil) for the mobile equipment is on average approx. 1.9 litres/tonne of input material.

Cross-media effects

Converts waste organic materials into valuable soil improvement products to be used in agriculture etc.

Driving force in implementation

Environmental benefits, reduction of landfilling and incineration of waste.

Economics

Income from reception of organic materials (treatment fee) and from sale of compost products.

Treatment costs, i.e. operating cost plus depreciation is approx. EURO 68 per tonne of input for composting of sewage sludge and approx. EURO 1.5 per tonne of input for garden waste.

Reference plant

Odense Nord Miljøcenter, Denmark

Position in the present BREF

Not included

4.1.5 Envor Biotech Oy, Finland**Description of the plant and of the technique**

Envor Biotec Oy is a company under the Envor Group. The company has established a biogas facility based on anaerobic digestion. The facility has two biogas reactors in operation, and a third one under construction.

The raw materials of the facility are bio-wastes such as organic household waste, kitchen waste from institutions etc., organic wastes from industrial production of food for human consumption, vegetable based oils and fat, sludge and organic wastes from agriculture and sludge from municipal waste water treatment. Outputs are energy in the form of biogas and remaining digestion matter which is almost odourless and can be used directly as a fertilizer or it can be converted to compost and soil improvement products. The input capacity of the facility is 56,000 tonnes of bio-waste per year. This amount of bio-waste is converted to 4 million m³ of biogas with an energy content of 26,000 MWh. The facility will also include a third line with a capacity of 28,000 tonnes per year.

The design of the facility is based on the following treatment system:

The pre-processing lines are built to handle industrial food waste and packaged groceries ready for reactor input. The huge variation in bio-waste sets high demands for every part of the pre-processing line. Bio-waste is first crushed and screened to a size of less than 50 mm. The crusher is modified for this specific purpose so food waste and packaged groceries can be processed simultaneously. The pre-processing line is automated with conveyors and electronic detectors to control the feed. The input has to meet very strictly controlled values for digestion/gasification; this is achieved by conveyors feeding the screen, metal detector and homogenizing unit. If impurities are detected, they are separated from the input waste material. Pure bio-waste is homogenized to a size of less than 12 mm; this mass is suitable for digestion/gasification after mixing with water.

Waste is forwarded to mixing tanks where the thickness of the sludge is set to a solids content of 12% by weight. The temperature of the sludge is then raised to 36°C using steam before being pumped into the

bioreactors where it stays for approximately 23 days. The total volume of the two bioreactors is 5,400 m³.

The residual solid material from the digestion process can be utilized as a fertilizer, although for the major part the residue is dewatered and used for soil production. This residue from the bioreactor is sold. It is almost odourless and can be used for fertilizing purposes in agriculture, horticulture and gardening. One tonne of biowaste generates 300 kg of digestion residue including nearly all of the phosphorous and almost all of the nitrogen contained in the input material.

The biogas generated in the plant is utilized to heat Enviro Group's own company premises and in electricity production. Electricity is also sold to the national grid. One option for utilization is selling biogas to industrial plants in the neighbouring area. In the future, biogas after purification can be used as a fuel for motor vehicles and possibly pumped into the natural gas network.

Applicability

The method is based on anaerobic digestion which is a well known process in biogas production and thereby easily adapted to different locations.

Environmental impact and benefits, energy efficiency

The process takes place in a closed system reducing impacts on the outside environment. Odour gases are collected and treated in an acidic scrubbing tower and biofilter.

Energy consumption is minimal due to the fact that the process, while fully operational, produces its own energy. Biogas engines are combined heat and power (CHP) units with a total energy efficiency of 85%. Furthermore the process includes heat recovery systems and electric motors with variable speed drives.

Energy efficiency is 95% in the plants using biogas for heating.

Cross-media effects

The produced biogas substitutes fossil energy resources for heating and fuel purposes thereby reducing CO₂ emissions. The process is almost odourless. Avoidance of landfilling of biowaste reduces methane emissions.

Driving force in implementation

Environmental benefits, reduction of landfilling of waste, reduction of greenhouse gas emissions.

Economics

Income is generated from gate fees and sale of biogas as well as from heat and power. Other utilization options include sale of biogas to local industrial

plants or usage after purification in cars and other motor vehicles. Income can also be generated by sale of the soil improvement products.

Reference plant

Envor Biotech Oy, Forssa, Finland

Position in the present BREF

Pos. 2.2.1

4.2 Objects in the BREF – Emerging techniques

4.2.1 *St1 Biofuels Oy, Finland*

Description of the plant and of the technique

St1 Biofuels Oy has developed and patented a new bioethanol production plant concept – Bionolix™. A conventional bioethanol process uses raw materials that contain sugar, starch or low concentrations of ethanol. Bionolix can use a wider selection of wastes and industrial by-products. The plant in Karanoja uses domestic and industrial bio-waste as feedstock.

The annual treatment capacity of the Bionolix plant is 19,000 tonnes of bio-waste which will be converted to approximately 1 million litres of bioethanol. The plant is a joint project in co-operation with the regional waste management company Kiertokapula Oy. Kiertokapula is responsible for the collection of source separated bio-waste from households, retailers and industry.

The Bionolix technology includes the following process steps:

- pre-treatment of the bio-waste including e.g. shredding of the feed and separation of bio-waste from food packaging materials
- warming of the bio-waste with the addition of water and enzymes
- fermentation
- drying and separation of solid material
- distillation up to 85% ethanol

The products of the Bionolix process are ethanol and solid biofuel. Solid biofuel is used to produce energy, part of which is used in the plant. The process also produces treated waste water.

Bioethanol is concentrated to 99.7% ethanol in another plant of St and used to produce ethanol-containing fuel for motor vehicles.

Applicability

St1 is developing new methods to utilize a wider selection of wastes and industrial by-products in bioethanol production. These new sources of feedstock increase the applicability of St1's dispersed biofuels production concept.

Environmental impact and benefits, energy efficiency

Bionolix units can be built near to the sources of suitable fermentable feedstock to minimize transportation costs. The process is self sufficient with regard to energy.

Cross-media effects

Reduction of CO₂ emissions: bio-waste based production of electricity and heat and bioethanol replacing fossil fuels.

Driving force in implementation

Environmental benefits, reduction of CO₂ emissions.

Economics

Sale of bioethanol, electricity and heat, minimization of transportation costs.

Reference plant

ST1 Biofuels Oy
Karanoja plant
Hämeenlinna, Finland

Position in the present BREF

Pos. 2.5.2.

4.3 Physico chemical treatment

4.3.1 *Objects in the BREF – Established techniques*

Ecopro AS, Norway

Description of the technique. Collected organic waste may contain unwanted objects that need to be removed before further processing. In the Ecopro plant solid waste passes an autogenous mill, which reduces particle size and removes oversized material (>110 mm). The autogenous mill can be described as a rotating drum and is equipped with cutters to open

plastic bags. The rotation of the drum forces the waste to grind against itself to reduce its size.

Objects smaller than 40 mm are accepted, fall through holes in the drum and are taken for further processing. Material between 40–110 mm falls through larger holes in the drum, and is recirculated back for another spin in the autogenous mill. Oversized material (>110 mm) is removed and is taken to external treatment. This fraction mainly contains plastic and textiles, and is sent to incineration.

Applicability

This method ensures that different types of waste can be processed at the biological treatment plant. In the past this type of process used to be done manually. The process is an example of taking known technology and putting it into new use.

Environmental impact and benefits, energy efficiency

The process is a net consumer of energy. The process ensures that different types of organic waste can be treated in the following process.

Cross-media effects

The process ensures that a high-quality end product can be produced through anaerobic digestion.

Driving force in implementation

Reduction of manual labour required to ensure an acceptable quality of organic waste for further treatment.

Economics

Income from receiving organic material (treatment fee), income from sale of soil improvement products and income from energy generation.

Reference plant

Ecopro AS, Norway

Position in the present BREF

Not included

4.3.2 *Peterson Linerboard AS, Norway*

Description of the plant and of the technique

Peterson Linerboard AS is a subsidiary of Peterson AS. It was founded in 1988 and is located in Trondheim, County Sør-Trøndelag.

The company produces and delivers kraft and test liner to corrugate and coreboard producers all over Europe.

The turnover in 2009 was NOK 1,125,050,000, and the share capital is NOK 20,000,000. The company has 375 employees.

The plant receives recyclable corrugated cardboard in compressed bales. The bales are broken up, and water is added to the cardboard in a pulper. Any impurities in the cardboard (plastic, metal) are removed in this step. The pulper transforms the cardboard to pulp. The pulp is heat treated, and starch is added. The amount of starch depends on the quality of the received cardboard and the desired quality of the end product. A higher quality end product will need more starch than a lower quality end product. The type of end product produced depends on the market situation and of customers at any given time. The starch adds strength to the new cardboard, and helps the speed of water removal.

Water is removed from the pulp in steps, first through a filterbed press, and then the mass is heated to produce the end product.

Applicability

The method ensures that sorted corrugated cardboard is recycled into new products. Corrugated cardboard is bought from companies that collect and sort paper waste.

Environmental impact and benefits, energy efficiency

The process uses energy and chemicals to recycle waste fibre. The factory has a discharge permit for its wastewater, which has a high organic content.

Cross-media effects

Reduced consumption of virgin fibre (i.e. timber).

Driving force in implementation

Environmental benefits, recycling of fibre, reduced consumption of virgin fibre (timber) and reduction of landfill need.

Economics

Income from sale of finished cardboard.

Reference plant

Peterson Ranheim, Norway

Position in the present BREF

Not included

TH Paulsen AS, Norway

Description of the plant and of the technique

Tor Henning Paulsen AS is a subsidiary of BIR Bedrift AS, which is owned by the intermunicipal waste company BIR AS. The company is located at Ytrebygda in Bergen, County Hordaland. The company was founded in 1986.

The company receives paper waste from households and companies, sorts the waste automatically, and puts the waste fractions into separate bales, which are sold to reprocessing factories.

The turnover in 2009 was NOK 32,935,000, and the share value is NOK 250,000. The company has 12 employees.

Waste input consists of paper, cardboard and beverage paperboard. Waste used to be sorted manually. Now the sorting is done automatically through optic readers. There are three optic readers, one for each fraction. The readers are connected to air nozzles, which blow the different fractions in opposite directions. The sorted paper, cardboard and beverage paperboard are put in separate bales, and sold to reprocessing factories.

Applicability

This method ensures that collected paper waste is sorted into fractions that can be used effectively for material recycling.

Environmental impact and benefits, energy efficiency

The process is a net consumer of energy. Sorting of different paper and cardboard waste fractions ensures that most of the waste can be recycled.

Cross-media effects

Produces sorted paper, cardboard and beverage paperboard that can be recycled.

Driving force in implementation

The need for sorted paper waste as an input material in process industry.

Economics

Income from receiving paper waste (treatment fee) and from sale of sorted materials.

Reference plant

TH Paulsen AS, Norway

Position in the present BREF

Not included

4.3.3 Gypsum Recycling A/S, Denmark

Description of the plant and of the technique.

Collection and recycling of gypsum is based on a patented treatment system, which is fully implemented and in operation in Denmark, Sweden, Norway, Ireland, UK, Netherlands, USA and Japan. The company was established in 2001.

The treatment system is able to process waste gypsum boards with impurities like wallpaper, glass tissue, glue, screws, nails etc. and separate all these impurities from the gypsum core. The resulting mass is crushed and supplied as a recycled gypsum powder to plasterboard plants for use when producing new gypsum boards. The recycled gypsum powder is 99% as good as virgin gypsum materials.

The capacity of each recycling unit is sufficient to cover recycling of all generated gypsum waste in Denmark, which is approx. 50,000 tonnes/year. Currently 80% of this quantity is recycled.

Applicability

The method is applicable to all gypsum board waste. The method is capable of ensuring an almost 100% recycling rate of the collected gypsum waste. Collection is accomplished by providing special collection containers at public recycling centres, waste collection and sorting facilities and construction sites.

Environmental impact and benefits, energy efficiency

Only alternative to recycling of gypsum waste is disposal at a landfill, where gypsum waste can pollute groundwater and create hydrogen sulphite gases. Secondly, recycling of gypsum waste will reduce the use of virgin materials in the production of gypsum boards, etc. and energy consumption in connection with extraction of virgin gypsum is saved. For each tonne of waste gypsum board recycled emissions of 0.2 tonnes of CO₂ equivalents are saved.

Cross-media effects

Less pressure on natural resources of virgin gypsum. The recycling has no negative environmental effects.

Driving force in implementation

Reduced need to landfill and environmental benefit.

Economics

Waste disposal fees and taxes are saved. Renewable raw materials for the gypsum board production industry are secured.

Lower costs for the waste owner.

Reference plant

Gypsum Recycling International A/S, Denmark

Position in the present BREF

Pos. 2.3.3.3.

4.3.4 Gamle Mursten, Denmark

Description of the plant and of the technique

Cleaning of old tile bricks for reuse is done in a patented mechanical operation, where remains of mortar are removed using various vibrating cleaning techniques. Following the mechanical operations the individual tile brick is inspected and if necessary a final manual cleaning is undertaken. Bricks are finally stabled by robots to industry requirements. The capacity per plant is 2,000–4,000 bricks/hour.

Applicability

Tile bricks for reuse are handled using ordinary demolition machines when old tile brick buildings are demolished. The only precaution is not to crush the demolition material with the belts or tires on the demolition machines/excavators. When used to construct new buildings experience shows that the bricklayers have no major problems using old tile bricks instead of new ones. Actually, it makes the work more interesting that not all the tile bricks are identical. All bricks are stabled by robot technology and delivered as to industry requirements.

Environmental impact and benefits, energy efficiency

Depending on the performed sorting efficiency between 30% and 80% of the old tile bricks can be reused in construction substituting new tile bricks. The remainder in the form of smaller pieces of bricks is mixed with soil to establish “green” roofing on buildings.

Cleaning and reuse of 2,000 old tile bricks saves energy and approx. 1 tonne of CO₂ emissions. This is based on an emission of approx. 0.27 kg CO₂/kg tile brick when producing new ones compared to an emission of 0.027 kg CO₂/tile brick for demolition and cleaning of old tile bricks. It is important to note that no water or chemicals are used in the cleaning process and no emission of odours takes place. If dust is a problem during dry weather conditions this is mitigated by applying a water mist.

In addition, if old tile bricks are not crushed and used as backfilling on roads, etc., reuse reduces use of available landfilling space.

Cross-media effects

Use of old tile brick when constructing new buildings can add to the aesthetics of the building and surroundings.

Driving force in implementation

Reduced CO₂ emissions. A clear and visible expression of the reuse and recycling concept on behalf of the owner of the building (makes a statement).

Economics

No direct economic benefits, old reusable tile bricks as expensive as new ones.

Reference plant

Gamle Mursten ApS. (Old Clean Bricks ApS.), Denmark

Position in the present BREF

Pos. 2.3.3.3.

4.3.5 Genan A/S, Denmark**Description of the plant and of the technique**

Genan is the largest recycler of scrap tyres in the world. Three large plants in Germany have a capacity to recycle 34% of all German scrap tyres and one plant in Denmark processes 90% of all Danish scrap tyres. The capacity of the Danish plant has just been doubled to 70,000 tonnes of input per year, which enables the Danish plant to treat tyres from other Scandinavian countries. In compliance with the vision, it is Genan's aim to process 10% of all scrap tyres in the world before the end of year 2018. It is estimated that 13.5 m tonnes of tyres are discarded every year. These figures include all sorts of tyres from car tyres to truck tyres and the huge tractor and earth moving equipment tyres.

Genan's end products are secondary raw materials of very high quality. The rubber powder and granulate are extremely uniform in size and clean and this makes them suitable for sophisticated and high-value applications like e.g. modification of bitumen and asphalt where virgin polymers are being replaced.

A tyre consists of rubber, steel and textile. The proportional mix of these three components depends on the type of tyre – whether it is for a passenger car tyre or for a heavier type of tyre. With modern technology, it is possible to separate scrap tyres back into these basic components so everything can be recycled. Scrap tyres received at the plant first have to be weighed and registered in order for the right settlement to take place.

The tyres to be processed are unloaded into a huge tyre pit. Automatic cranes above the tyre pit ensure that the tyres are removed continuously from the part of the pit closest to the gates. The cranes also feed the assembly lines with tyres for the shredders.

The shredders produce rubber chips of 25–50 cm. During the first step of the process, the tyres are rinsed with water, which is reused in an optimal environmentally friendly re-circulating system after the impurities like sand, stones and mud have settled. After the shredder has reduced the tyres into big chips, they continue through an intermediate storage to the first granulator, which reduces the size of the rubber chips further down to approx. 1.5 cm. Already at this point 80–90% of the steel has been liberated by the use of a magnetic system. The main material, which now predominantly consists of rubber containing small amounts of steel and textile, is transported further on and separated into two fractions. The smallest particles are transported directly to the next step, where they are sieved and rinsed. The biggest particles go through a new granulation until they are small enough. In the final step of the process the rubber granulate is split up in the wanted sizes and cleaned to remove the last remains of steel, textile, stones and sand. This is an extensive process using different high technology separation techniques in several steps of the production. All processes of the production of granulate are mechanically based. Neither nitrogen nor other subsidiary materials are used.

Depending on the requirements, granulates can be further reduced down to rubber powder of varying degrees of fineness. For that purpose special mills are used, in which the material is accelerated up to supersonic speed until crushed into powder. The powder may either be produced totally mechanically (ambient), or by addition of fluent nitrogen (cryogen), or by a combination of both these methods. Mechanically ground powder has a big and irregular surface structure, which makes it suitable for combination with rubber compounds. Cryogen ground powder has a smooth and uniform surface structure, which for instance makes it suitable for use in paint or other products, which pass through nozzles when used.

The rubber can be produced in different sizes, from the finest powder (below 0.2 mm) to the coarse granulates used for a variety of purposes. In order for recycled rubber to find widespread applications as replacement for new rubber, it is extremely important that the quality of the recycled rubber is high. It must be totally pure and the size of the particles must be uniform. Only when these quality requirements have been met, will industry find that recycled rubber is a financially attractive alternative to new polymers.

The output consists of 67% rubber powder and granulate, 18% steel, 14% textile and 1% waste, which primarily originates from impurities like sand and stones absorbed by the scrap tyres. 99% of the output is therefore recycled for good use in new applications which are able to substitute virgin materials.

The rubber is used in numerous applications, currently the most important being modification of asphalt and bitumen, infill in artificial turf and industrial rubber applications.

The steel is remelted in large steel works. The textile has so far been incinerated for energy recovery but is currently going through a comprehensive product development which will lead to final products within the noise and heat insulation industry.

Applicability

The method is capable of ensuring an almost 100% recycling efficiency of collected scrap tyres.

Collection of scrap tyres in Denmark is secured by paying a fee on new tyres to the Danish tax authorities. Payment of subsidies for collection of scrap tyres is administered by the Danish Tyre Council and enables a collection rate of more than 95% of scrap tyres for recycling.

Environmental impact and benefits, energy efficiency

Recycling of scrap tyres will save landfill space, and landfilling is anyhow no longer an option in the EU according to the landfill directive. In addition comprehensive life cycle assessment (LCA) studies show beyond any doubt that recycling is significantly more environmentally beneficial than incineration in all impact categories researched. In this context it should be noted that 6 kilos of oil have been used in the process of producing 1 kilo of tyres.

Cross-media effects

The rubber is used in numerous applications, currently the most important being modification of asphalt and bitumen, infill in artificial turf and industrial rubber applications thereby substituting virgin raw materials.

Driving force in implementation

Reduced landfilling of tyres, which is now prohibited in the EU in accordance with the landfill directive. Reduced CO₂ emissions when using recycled rubber compared to production of new rubber materials.

Economics

Waste disposal or waste incineration fees and taxes are saved. Renewable raw materials for industries using rubber are secured.

Reference plant

Genan A/S, Denmark

Position in the present BREF

Pos. 2.3.3.3.

4.3.6 Novopan Træindustri A/S, Denmark**Description of the plant and of the technique**

Novopan is the only chip board producer in Denmark using waste wood as a raw material. Chip board production is primarily based on bi-products from the wood processing industry, i.e. from saw mills, furniture production and forestry. In addition source separated wood waste from collection at amenity centres and from demolition activities is used as raw materials in the production of chip boards. Wood waste containing dangerous substances, e.g. impregnated wood is not used in the production.

The received wood waste is shredded and impurities such as metals, stones, glass etc. are separated from the waste wood. The initial shredding and cleaning of wood waste consumes slightly more electrical energy compared to the use of virgin raw materials. Following the shredding and cleaning the chips are dried in ovens before entering the chip board production line. Compared to the use of virgin raw materials the energy consumption for drying is considerably lower.

Wood waste from the plant itself is used for production steam for the plant covering app. 1/3 of the plant's electricity consumption.

Applicability

The method is capable of ensuring an efficient recycling of wood waste. Collection is accomplished by providing special collection containers at civic amenity centres and construction sites, thereby securing a clean and dry raw material for the recycling process. Further, the plant and its customers have established a recycling business relationship, and waste from customers is delivered directly to the plant by the trucks collecting chip boards. This arrangement is of mutual benefit and it reduces the environmental impact.

Environmental impact and benefits, energy efficiency

In 2009/2010 a total quantity of approx. 100,000 tonnes of wood waste and approx. 20,000 tonnes of chip board waste was received at the plant. The increased energy consumption for shredding and cleaning was 1,048,760 kWh (equal to 12.3 kWh/tonne of dry matter at 91% dry matter) and for internal transport 10 tonnes of diesel oil. The energy saving

from drying of chips was equal to 5,700 tonnes of heavy fuel oil. A life cycle assessment shows that chip board production based on wood waste is superior to the use of wood waste as a fuel in power plants or in waste incineration facilities, both regarding energy use and environmental impacts, such as saving virgin wood, and extending the life time of wood (both of which will save CO₂).

Cross-media effects

Reduces energy consumption.

Driving force in implementation

Energy savings and reduced costs of disposal of wood waste at waste incineration facilities (treatment costs and disposal taxes), and reduced use of traditional raw materials (virgin wood residues) due to increased burning of wood for energy production.

Economics

Less costly raw materials compared to virgin materials plus saving of energy costs.

Reference plant

Novopan Træindustri A/S, Denmark

Position in the present BREF

Pos. 2.3.3.3.

Objects in BREF – Emerging techniques

4.4 Other treatment operations

4.4.1 *Objects in the BREF – Established techniques*

AkkuSer Oy, Finland

Description of the plant and of the technique. Akkuser Ltd. is a company established in 2005. The company has developed its own recycling methods for batteries and accumulators. The technology developed by AkkuSer enables the processing of recycling material into valuable metals suitable as a raw material for industry. The waste materials received at the plant are: lithium-ion (Li-ion) accumulators, nickel-metal hybrid accumulators (ni-mh), nickel-cadmium accumulators (ni-cd), alkaline batteries and accumulators and pre-treated electronic waste.

The Akkuser plant receives, stores, sorts and recycles batteries and dry accumulators classified as hazardous waste. Feedstock includes all types of wireless products, such as digital cameras, video cameras, mobile phones, computers, and battery-powered drills. The waste is delivered to Akkuser Ltd. by waste management companies and organizations in Finland, Sweden, Norway, Denmark, Estonia and Austria. The capacity of the plant is at the moment 4,000 tonnes per year, but according to their environmental permit the company can increase the capacity up to 5,000 tonnes per year.

The Dry Technology technique works as follows:

- the received battery and accumulator shipment is controlled, weighed and data is recorded
- accumulators and batteries are separated based on the chemical and/or metal content with two semi-automatic sorting lines
- currently only Li-ion and nickel-metal hybrid accumulators (ni-mh) are treated with the Dry Technology; other waste batteries and accumulators are delivered to appropriate processing plants
- battery and dry accumulator batches are crushed separately in two stages, first roughly and after that into finer fractions
- the dust produced in the crushing process is collected by cyclones and filters and returned to the product
- magnetic iron can be separated in the process
- during the crushing process temperatures are 40–50°C
- end products are in powder form and are delivered for further refining in foundries
- plastic and cardboard recovered from the waste is utilized in energy production

Applicability

AkkuSer's Dry Technology can be used for part of waste batteries and accumulators. AkkuSer is developing a new process (Dry Chem) especially for alkaline batteries.

Environmental impact and benefits, energy efficiency

Material recovery rate of the process is 90%. Energy consumption is 0,3 kWh/kg which is 95% less than in the alternative foundry technology.

Cross-media effects

No waste to be landfilled, reduction of CO₂ emissions, no waste water, no emissions to air.

Driving force in implementation

Material and energy saving.

Economics

Sale of raw materials to metal industry, gate fee for part of the batteries and accumulators

Reference plant

AkkuSer Ltd, Nivala, Finland

Position in the present BREF

Not included

4.4.2 Cool Finland Oy, Finland**Description of the plant and of the technique**

Cool Finland Oy is a company owned jointly by the regional waste management company Loimi-Hämeen Jätehuolto Oy (50%) and Oeko-Service Luxemburg SA (50%). The company is specialized in the treatment of refrigerators and freezers. Ozone-depleting substances (ODS) e.g. CFC compounds in refrigerators and freezers are bound in the cooling circuits and in insulating materials of the refrigerators. In the process CFC gases are trapped for further treatment and recyclable materials are collected for utilization and further processing.

- The capacity of the facility in Forssa is approximately 11,000 tonnes per year of appliances. Process equipment supplier of the facility is SEG Umwelt-Service GmbH. The process includes the following steps:

- The pre-processing stage involves the extraction of the mixture of oil and ODS from the cooling circuit and the subsequent separation of the mixture into its components by passage through a sequence of thermal and pressure treatment units
- Once the cooling circuit has been extracted, the empty compressor is cut from the appliance using the facility's hydraulic shears and the glass shelving; cables, mercury switches and capacitors are also removed
- The final processing stage involves the shredding of refrigerator and freezer appliances and the recyclable materials are retrieved
- To remove ODS from the polyurethane insulant, the separated PU flakes are first degassed, ground and then subjected to controlled heating to thermally desorb ODS from the polyurethane matrix
- The gaseous ODS released is trapped with a regenerable activated carbon filter system
- ODS are desorbed from the carbon filters and cooled and condensed
- The exhaust gas stream is continuously monitored in order to detect and prevent loss of ODS
- The steel is extracted using a special separator, and non-ferrous metals and plastics are collected separately

The recycling rate of the input is 95% covering both material and energy recovery including: Cables, metal compressors, Fe-fraction, aluminium, polystyrene, polyurethane and compressor oil. Mercury switches and the condensed gases are delivered to disposal.

Applicability

The process is applicable to most (approx. 96%) refrigerators and freezers containing ODS (CFCs, HCFCs, HFCs as well as hydrocarbons). Appliances containing ammonia cannot be treated.

Environmental impact and benefits, energy efficiency

The process removes efficiently the ozone depleting substances from the appliances. Typical recovered amounts are: 330 g of insulant gas and 115 g of coolant gas.

Cross-media effects

The recyclable materials are recovered efficiently and can be used as a material or energy resource.

Driving force in implementation

Environmental benefits, efficient evacuation of ODS and comprehensive material recycling.

Economics

Income from receiving raw materials and from sale of the recycled raw material.

Reference plant

Cool Finland Oy, Finland
Envitech Area, Forssa

Position in the present BREF

Pos. 2.4.

4.4.3 Hedinn hf, Iceland**Description of the plant and of the technique**

Hedinn hf is a service and knowledge-based company in the metal and engine technology. The main target groups are fishing vessels (>70 m), fishmeal factories and the heavy industry. The company has grown over time and has great personnel, first class hardware, accommodation and facilities. Hedinn's goal is to promote increased customer prosperity. The demanding Icelandic industry and consumers will be insured the most economic technologies at any time with a systematic product development and import of knowledge, excellent equipment and materials. Hedinn hf. also aims to be at the forefront of implementing technology and equipment that contributes to environmental protection and energy savings, thereby serving public interest.

Hedinn hf delivered its first fish meal factory in 1936 and since then Hedinn hf. has been involved in numerable projects in the fishmeal industry, the latest one as a turnkey contractor of a new factory for HB Grandi hf in Vopnafjordur delivered in 2010 and a factory on board a trawler built for a Faroese fishing company and delivered in 2009.

Most fish meal factories are large scale, producing up to several thousand tonnes per day of meal, and therefore depend on a steady and close-by source of material. In the Nordic countries, fish by-products are commonly produced in rural areas where it has not been economical to treat and transport by-products to the closest factory. More economical solutions are therefore needed for those producers.

Production of fish meals is based on a conventional technique. The raw fish or the fish by-products are heated to 90–100°C in a boiling unit

with indirect steam. Water and oil are pressed out. The press cake is then transferred to a dryer and the press liquor to a sludge centrifuge. The decanter sludge is further conveyed to the dryer together with the press cake. The press liquor then goes to the disc centrifuges where the oil is separated. The stickwater goes to multiple effect evaporators producing a soluble that goes to the dryer. The product is generally called a whole meal.

The main difference compared with the small-scale plant is that the fish oil is separated from the whole fish without any pressing needed and the rest is moved directly to drying. This method is simple compared to the conventional process, because the pressing process as well as the total liquid stage is no longer needed.

The plant components come from the following producers:

- Hedinn hf. All components other than decanter and control system
- El-Run ehf Electricity and control system
- GEA Westfalia Decanter

The plant is now being run and tested at HB Grandi hf. in Reykjavik, Iceland. The trials are on schedule so far, and the results are promising. The goal is to build a plant with a capacity of 300 kg of raw material/h which can be available on the market before end 2011 and the first plant with the capacity of 2,000 kg/h finished before the end of 2012.

Applicability

The technique is applicable to all sources of fish by-products.

Environmental impact and benefits, energy efficiency

Reduction of CO₂ emissions. Less disposal of fish by-products. Higher quality meal as a result of fresher raw material input.

Cross-media effects

As discussed above.

Driving force in implementation

Economical, small labour. Mobile.

Economics

A clearly positive impact for the environment and for the fish processing industry.

Reference plant

Hedinn hf., Iceland.

Position in the present BREF

Not included.

4.4.4 Isfelagid Vestmannaeyjum hf, Iceland**Description of the plant and of the technique**

Isfelag Vestmannaeyja hf was established in 1901 in the Westman Islands and has been one of the leading companies in the fishing industry in Iceland. The company owns seven fishing vessels for fishing of different species. Today it runs a combined fish meal factory and fish processing plant at Thorshofn on the northeast part of Iceland and another combined plant on the Westman Islands. Each of these fish meal factories can process up to 1,000 tonnes per day of raw material. The raw material and by-products come from cod, pollock, herring, haddock, mackerel, blue whiting and capelin. The quality of the company products increases steadily with increased instant freezing at sea and more export of fresh fish to markets. The processing efficiency also increases steadily with more and better use of by-products from the fish, e.g.. such as recovery of solids and fat from process water.

The Pelagic fisheries in Iceland are the foundation for filleting, freezing and fish meal production. The raw material is pumped from a vessel's cool storage tanks up to the filleting/fish meal plants. For obtaining good quality of the raw material and to prevent damage it is essential to maintain cooling and it is necessary to use large amounts of water (up to 50% water) for pumping the raw material from the ship to processing. The offloading capacity is usually in the range of 50–100 m³/h and the water usage for pumping is usually 25–50 m³/h. In many cases the offloading from vessels can take up to 24 hours. In such instances, the offloading water becomes polluted with fish offal. Fresh water is added to the offloading circulation throughout the offloading period to decrease the viscosity and to improve the pumping ability. At the end of the offloading there are large quantities of water stored in the serum water

tanks that need to be evaporated for meal and oil production in the fishmeal factory.

In Iceland the fish meal process is built up in a similar way as in the other Scandinavian countries whereas in Iceland the fish meal is mainly produced from capelin and herring/ mackerel (offal).

The raw material is pumped directly from a vessel to storage tanks and from there into the processing area , “cooking”, where it is heated up to 90–100°C for the denature of the proteins and the destruction of binding abilities between water and oil. After boiling, the material enters a press where as much water and oil as possible is pressed out from the hot mass. After pressing, the press cake is conveyed directly into the dryers and the press liquid enters the sludge centrifuge (decanter). From the centrifuge the sludge enters the dryers directly and the liquid effluent from the decanter enters the disc-centrifuges where the oil is separated from the pressed liquid. The disc-centrifuge liquid (stickwater) is further processed in an evaporation system where it is transformed into a concentrate called soluble. The soluble is usually processed further in a centrifuge for removal of the remaining free oil before it is combined with the press cake before entering the dryers.

In short terms the fish meal consists of the press cake, the decanter sludge and the soluble and is called a whole meal.

From 1998 a few Dissolved Air Flotation (DAF) units have been installed in the fishmeal and fish processing factories in Iceland. The main purpose of the DAF units is to continuously treat the fish offloading water and to treat water coming from fish processing. The offloading water is then reused. Such systems have now been installed at the fish meal factories of Isfelag Vestmannaeyja hf. in Thorshofn, Iceland and in the factories at Krossanes, Vestmannaeyjar, Djupivogur and Grindavik.

Fishmeal factories and fish processing factories in Iceland are usually run combined for many reasons. One reason is the large amount of offal coming from the fish processing which then can be transferred directly to the fishmeal factory for meal and oil production. At Isfelag Vestmannaeyja hf. in Thorshofn DAF units have been chosen to recover dry material and fat from the fish offloading water and water from the fish processing factory.

A research study of the efficiency of the DAF systems in the fish offloading process has shown a removal of the dry material of up to 60–70% and up to a 85–90% removal of the fat. The recovery of the dry material and oils is even greater for DAF units installed in a fish processing i.e. in the herring filleting process.

Isfelag Vestmannaeyja hf. has installed DAF systems at its fish meal and fish processing plants in Thorshofn and the Westman Islands.

Applicability

The technique is applicable in treating contaminated water in most fishing industries and also in the other food industries i.e. in the slaughter industry.

Environmental impact and benefits, energy efficiency

Less disposal of fish by-products.

Cross-media effects

Less ocean contamination.

Driving force in implementation

Economic and environmental benefits.

Economics

Positive impacts for the environment and the fish industry.

Reference plant

Isfelag Vestmannaeyja hf. in Thorshofn Iceland.

Position in the present BREF

Not included.

4.4.5 L&T Recoil Oy, Finland**Description of the plant and of the technique**

L&T Recoil Oy is a joint venture company owned by the Finnish companies EcoStream Oy and Lassila & Tikanoja plc. L & T Recoil is specialized in used oil re-refining. The plant is built in Hamina Harbour which enables efficient collection of the feedstock around the Baltic Sea area.

The plant uses distillation and hydro-finishing technology to re-refine used lubricant oils into base oils, which can be used as a raw material for new lubricating oils. The annual capacity of the plant is 60,000 tonnes.

Used lube oil re-refining includes the following steps:

- removal of water and light ends
- base oil fraction is separated from bitumen by thin-film evaporation
- remaining impurities are removed from the base oil fraction and stabilized by catalytic hydrogenation
- the lubricant fraction is separated into different base oil fractions by distillation

Estimated amounts of the products are as follows:

- 45,000 tonnes/y of base oils
- 9,000 tonnes/y of bitumen
- 4,000 tonnes/y of fuel oil

The light end gas is used as a fuel for the re-refining process. Fuel oil and bitumen are sold as a fuel or for further treatment (desulphurization) to other companies. The bitumen fraction can also be used as an asphalt extender.

Applicability

Re-refining is suitable for used lubricating oils and can also be used to improve the quality of low-grade base oils.

Environmental impact and benefits, energy efficiency

Base oil fractions in waste oils are recycled to raw materials for new lubricating oil.

Cross-media effects

Conservation of global mineral oil resources. Reduction of environmental impacts associated with waste oil re-refining compared to primary production of lubricants and compared to incineration. Carbon foot print of re-refined base oil is up to 60% compared to virgin base oil. Separated contaminants are incorporated in bitumen fraction.

Driving force in implementation

Recycling waste material into saleable products.

Economics

Income from sale of base oils, income from sale of (by-products) light fuel oil and bitumen.

Reference plant

L&T Recoil – Re-refinery, Hamina, Finland

Position in the present BREF

Pos. 2.4.1.

4.4.6 Muovix Oy, Finland

Description of the plant and of the technique

Muovix Oy is a privately owned company recycling plastic waste in its own production facilities. The company has knowledge on a wide variety of plastic types and their recycling potential. Muovix receives plastic waste from industries and other businesses and refines the raw material into a Muovix profile. Typical plastic wastes are packaging materials such as LDPE film, containers, coils and boxes. Muovix uses large quantities of plastic wastes produced by assembly and electronic industries. Even wastes that are normally difficult to recycle (e.g. glass fibre reinforced plastics) can be utilized as a filler material.

Every waste delivery is checked beforehand in order to know the qualities and to be able to plan production. Incoming batches of waste plastics are received and the quality is controlled visually. Plastic waste is stored according to qualities.

The treatment capacity of the plant is 8,000 tonnes of plastic waste per year. The production of Muovix profiles is carried out as follows:

- based on the contents waste plastics from the storage silos enter the process via a conveyor with a metal detector
- the plant has two parallel pre-treatment lines: (1) hard plastic material goes to a fine crushing and (2) plastic films are agglomerated
- the pre-treated plastic material is moved to storage bins
- from the storage bins the raw material is fed to a mixer and a colorant is added
- the mixture goes to an extruder where the material is melted and formed into profiles

The end product looks like wooden plank or pole depending on the form of plastic extrusion. A typical profile has a length of 2–3 m and a diameter of 16–150 mm. Shapes are round, square or rectangular.

The end product can be shaped with different methods similar to working with wood. Muovix profiles can be used instead of weather-proof wood.

Applicability

The method can be adapted to different kinds of plastic materials and the end product can be formed to different kind of applications.

Environmental impact and benefits, energy efficiency

Recycling of mixed plastic waste as an alternative to incineration with energy recovery.

Cross-media effects

Muovix profiles substitute weatherproof wooden materials. Less impregnated wood is required, and ultimately less hazardous waste is produced.

Driving force in implementation

Material recycling method for mixed plastic wastes.

Economics

Income from sale of Muovix products.

Reference plant

Muovix Oy, Riihimäki, Finland

Position in the present BREF

Pos. 2.4

4.4.7 Onni Forsell Oy, Finland**Description of the plant and of the technique**

Onni Forsell Oy has since 1978 focused on the reconditioning of used barrels and other containers. The company has at present an automated production line in the Rajamäki plant.

The annual reconditioning capacity of the plant is 255,000 barrels, 40,000 IBC containers and 1,000 smaller containers. Reconditioning includes stages such as cleaning, refurbishing and painting.

The process line for barrels has the following steps:

- barrels are unloaded from the transport containers and inspected visually
- barrels with plugs are moved to the process and placed upside down for drainage
- having passed through an oven the barrels are empty from liquid contents
- barrels are conveyed to an automated refurbishing machine to repair the possible dents in the ends or sides of the barrel
- barrels are washed both from the outside and the inside with lye (>pH 13) and then flushed with water

- barrels with removable cover plates are placed in the washing machine manually (without the covers)
- barrels are dried with hot air
- barrels are controlled visually and sorted into recyclable and disposable barrels
- recyclable barrels are shot blasted and the tightness is tested
- barrels are painted with either solvent-based or water-based paint and dried in an oven

ICB containers are drained, washed and dried in a separate conditioning line.

The drained liquids (e.g. oils and solvents) are managed as hazardous waste. Washing lye is circulated in the washing process several times and delivered to hazardous waste disposal. Flushing waters are led to sewer after passing the plant's own water treatment process.

The outcome from the process is a clean and usable barrel or container.

Applicability

The method is based on well known processes and the size of the plant can be adapted according to needs of the operator.

Environmental impact and benefits, energy efficiency

Barrels can be recycled up to 5 to 6 times before recycling of the steel material. The carbon footprint of the reconditioned barrel (multiple use) has been estimated to be 2 times lower than the “single use” barrel (recycled as metal scrap), 15.3 kg of CO₂ per barrel and 30.7 kg of CO₂ per barrel respectively.

Cross-media effects

Proper reconditioning ensures that hazardous materials are removed from the used containers.

Driving force in implementation

Recycling waste material into saleable products.

Economics

Income generated from receiving the barrels and income from sale of the reconditioned barrels.

Reference plant

Onni Forsell Oy, Rajamäki, Finland

Position in the present BREF

Pos. 2.4.

4.4.8 *Primex ehf, Iceland*

Description of the plant and of the technique

Primex ehf is an Icelandic marine biotech company established in 1997 and located in the town of Siglufjörður on the north coast of Iceland. Primex is a manufacturer and supplier of pure chitin and chitosan derivatives. The company is dedicated to innovation and markets scientifically sound and novel natural ingredients for use in numerous markets like nutritional, cosmetic, food and biomedical. It has also its own private brands: LipoSan Ultra®, a patented and clinically proven weight loss product and ChitoClear™, a wound healing gel.

The shrimp shell used in the production of chitosan is a waste from shrimp plants that are partly owned by the mother company of Primex. The company is processing more than four thousand tonnes of shrimp shell that would be landfilled if not used by Primex for the chitosan production.

The basic raw material used to make chitosan is chitin. Chitin is a natural biopolymer composed mainly of glucosamin-2-amino-2-deoxy- β -D-glucose and the structure is similar to cellulose. It is harvested from the shells of crustaceans such as shrimp, crab and lobster. Chitosan is formed by deacetylation of the chitin and a positively charged biopolymer is obtained which is a natural dietary fibre. Chitosan produced at Primex is exclusively made from the shell of the North Atlantic shrimp, *Pandalus borealis*, that comes from the cold, pure and unpolluted Arctic water north of Iceland which accounts for its high quality and low amount of contaminants such as heavy metals. Chitosan has excellent biocompatibility, is biodegradable and has low toxicity.

The catching of shrimp in Iceland is carefully regulated by an official quota system to guarantee rational exploitation of the stocks and a sustainable balance in the marine environment. All decisions are based on scientific criteria and careful work of the Icelandic Marine Research Institute.

The process for producing chitosan from shrimp shell waste is in two steps:

- Isolation and purification of chitin
- Production of chitosan by deacetylation of chitin

In the first step the chitin is isolated from the other ingredients. The proteins are hydrolysed and removed by a treatment in a dilute solution

of sodium hydroxide (at high temperature, 85–100°C). Shells are then demineralised to remove calcium carbonate by treating in a dilute solution of hydrochloric acid.

In the second step the chitin is deacetylated in a strong solution of sodium hydroxide (>40%) at high temperature (90–120°C), and chitosan is formed. The degree of deacetylation will vary according to the duration, the temperature and the concentration of the sodium hydroxide. Furthermore, many chemical characteristics of the chitosan (molecular weight, polydispersity, purity) are greatly dependant on the method, the equipment used and also of the source of the shells. It is therefore crucial to control precisely methods of production of the chitosan to obtain the exact characteristics needed for end use application of the product. The plant has the capacity of processing 15,000 tonnes of shrimp shell waste per year. The process is shown in more details in the flowchart overleaf.

Applicability

The method is applicable to all shells of crustaceans such as shrimp, crab and lobster.

Environmental impact and benefits, energy efficiency

The company is processing every year more than 4,000 tonnes of shrimp shell, and other alternatives like landfilling would constitute a large environmental burden.

CHITOSAN MANUFACTURING PROCESS

Cross-media effects

Landfilling of shrimp shell waste causes production of greenhouse gases, e.g. methane.

Driving force in implementation

- Reduced environmental impact of waste from shrimp processing plants
- Increased energy efficiency
- Increased productivity
- Cost savings
- Saving natural resources

Economics

Income from sale of chitosan products. Estimated annual cost for delivering the shell for landfilling would cost the shrimp processing plants around 550,000 EUR per year.

Reference plant

Primex ehf, Siglufjordur, Iceland.

Position in the present BREF

Not included.

4.5 Objects in the BREF – Emerging techniques

4.5.1 *ZenRobotics Ltd, Finland*

Description of the plant and of the technique

ZenRobotics Ltd., founded in 2007, is a Finnish high-tech company specializing in robotic recycling technology. The company's main product is ZenRobotics Recycler, a waste sorting system separating raw materials from waste.

ZenRobotics Recycler is designed for commercial and industrial waste, municipal solid waste, and construction and demolition waste. The system uses multiple sensor inputs to identify items and raw materials. Possible sensors include Visible spectrum cameras, NIR, 3D laser scanners, haptic sensors, transillumination etc. ZenRobotics Recycler can perform multiple simultaneous sorting tasks; reclaim various raw materials and remove contaminants from the main stream.

The system is based on sensor fusion technology, which is a combination of sensory data from multiple sensors to form a coherent overview. It is also possible to learn to use sensors by combining the data streams through machine learning methods to provide information that would be impossible to obtain just by the disparate sensors themselves.

ZenRobotics Recycler can perform multiple simultaneous sorting tasks; reclaim various raw materials and remove contaminants from the

main stream. For example, contaminant removal may include the separation of unwanted materials like electronics, PVC, and minerals from the resulting burnable fraction.

The first process unit will be delivered to SITA Finland Oy.

Applicability

Designed to treat various solid waste materials.

Environmental impact and benefits, energy efficiency

The process is designed to make the sorting process more efficient, so waste materials which would otherwise have been disposed to landfills can be recycled and utilized.

Environmental impact and benefits, energy efficiency

The process is designed to make the sorting process more efficient and safer than traditional processes; e.g. recovery of good quality recyclables or recovery of contaminants from the RDF fraction.

Cross-media effects

Less waste to be landfilled, reduction of CO₂ emissions.

Driving force in implementation

Efficient and safe material recovery.

Economics

Income generated from receiving the waste materials and income from sale of recyclables.

Reference plant

To be delivered to SITA Finland Oy Ltd., Finland

Position in the present BREF

Pos. 2.4.

4.6 Treatment operations for energy recovery

4.6.1 *Objects in the BREF – Established techniques*

DAKA Biodiesel Production, Denmark

Description of the plant and of the technique. Daka a.m.b.a. is a cooperative society owned by 16 members. These members represent most of the Danish meat industry, and they also include the Swedish slaughterhouse Scan AB. The primary objective for DAKA is to make use of by-products from the abattoir and meat industry, which cannot be used for human consumption. Raw materials also include dead life stock and food waste. As a recent activity Daka has also established a production facility for biodiesel.

Biodiesel consists of fatty acid methyl esters (FAME) created as the result of a reaction between an alcohol and oils/fats of vegetable or animal origin. Methanol (wood alcohol) is usually the alcohol of choice, but ethanol may also be used.

The use of by-products for the production of biodiesel presents a number of challenges as opposed to the use of pure plant oils. The content of free fatty acids is significantly higher, which may lead to processing problems if these are not converted into fatty acid methyl esters before the conversion of the fatty substances. This means that the conversion process involves two stages: the first comprises an acid pre-esterification using sulphuric acid as a catalyst, followed by the trans-esterification of the fatty acids under alkaline conditions with the addition of an alkaline catalyst, typically potassium or sodium hydroxide.

Process flow diagram for Daka Biodiesel

The use of animal fat also requires an improved final refining process since it contains a number of micro-components that may present a sediment problem unless they are removed. The biodiesel is therefore subjected to a final distillation process, where fatty acid methyl esters are fractionated into light and heavy fractions. This stage also ensures a low sulphur content in the final biodiesel (<10 ppm).

The process gives a yield of approximately 1 tonne of biodiesel per tonne of fat. The energy used for the production is <10% of the energy content in the raw material.

In addition to biodiesel, the production process results in glycerine and potassium sulphate.

The second generation biodiesel plant has a capacity of 55 million litres of biodiesel per year but it is constructed with a view to expanding the capacity to 100 million litres per year.

Applicability

Biodiesel has to fulfil the EN 14214 standard which allows for blending up to 7% of biodiesel into fossil diesel according to EN 590. This B7 blend is accepted by all car manufactures. The use of higher rates is pos-

sible for certain vehicles, e.g. with the introduction of more stringent service requirements.

Demands for biodiesel are expected to increase in the future. The European Commission wants the use of biofuel in the EU to rise to 5.75% by the end of 2010, and most Member States have already implemented measures to meet this target.

Environmental impact and benefits, energy efficiency

Biodiesel is a CO₂ neutral alternative to fossil diesel and fuel oil, and as such it may reduce our dependence on fossil fuels.

Many studies also indicate that particle pollution is significantly reduced with the use of biodiesel, which is why it is used in urban buses in a number of large towns and cities, including Graz in Austria. Biodiesel also provides cleaner combustion and good lubrication of the engine, where it can replace standard additives.

In the event of environmental spills, biodiesel decomposes faster. Among other things, this reduces the risk of pollution from residential oil tanks.

Biodiesel may, however, result in an increase in the emission of nitrogen oxides. The future use of biodiesel should therefore be considered in conjunction with various filter systems designed to reduce the amount of hazardous materials in car exhaust fumes.

Cross-media effect

Development of second generation production plants designed to use waste byproducts rather than foodstuffs as the raw material in biodiesel.

Driving force in implementation

The produced biodiesel substitutes fossil energy resources for fuel purposes thereby reducing CO₂ emissions. In the Renewable Energy Directive Animal Fat biodiesel has a default CO₂ reduction efficiency of 83%. The high efficiency is obtained through the use of residues and waste materials, where no carbon emission is allocated prior to processing. Apart from the carbon dioxide reduction a main driving force for the production and use of biofuels is to provide a safer energy supply for the transport sector.

Economics

Biodiesel is still costlier to produce than mineral diesel. The use of biodiesel is therefore conditional upon a reduction in taxes or demands for an obligatory admixture rate into mineral based diesel.

Reference plant

DAKA Biodiesel Production a.m.b.a, Denmark

Position in the present BREF

Pos. 2.5.2.5 (only vegetable waste)

4.6.2 Domsjö AB, Sweden

Description of the plant and of the technique

The bio-refinery “Domsjö fabriker” is located in Örnsköldsvik, on the shore of a bay of the Baltic Sea. In recent years, production has developed away from traditional paper pulp as the main product to an advanced bio-refinery which manufactures special celluloses, ethanol and lignin, environmentally sound alternatives to cotton and synthetic textile fibres.

As one part of the company’s environmental efforts, Sweden’s then largest biological waste treatment plant was opened in 1985. In this plant, wastewater is treated in two stages, the first of which is anaerobic digestion to produce biogas, and the second is an aerobic step with free access to oxygen. The biological treatment plant is highly efficient, purifying 2,070,000 m³ of wastewater annually but with sufficient capacity to treat more. Wastewater from the bio-refinery “Domsjö fabriker” and from nearby chemical plants run by Akzo Nobel and Sekab is used as a substrate for the first anaerobic step in the biological treatment process. Digestion takes place in two reactors with a total volume of 30,000 m³, with continuous mixing. The retention time is 3 days in the anaerobic step, which has a process temperature of 37°C.

The energy in the biogas is exploited for heating within the company using a steam boiler and production of electricity. After anaerobic digestion, the wastewater moves on to an aerobic step where the decomposition of the substrate continues in aerated basins. The sludge produced from the anaerobic digestion step is returned to the process as it contains active micro organisms that are critical for the process. The sludge from the aerated step also contains bacteria and other suspended material and is used to produce soil conditioners.

Applicability

The biogas plant is continuously being developed and improved to remove bottlenecks and increase the capacity to accept more wastewater. Decomposition of the organic substrate is already very efficient, and the plant produces large amounts of biogas.

Environmental impact and benefits, energy efficiency

The efficient biological treatment of industrial wastewaters from Domsjö fabriker, Akzo Nobel and Sekab has resulted in much cleaner discharges from these factories. Measurements show that ecological

conditions in the bay of Örnsköldsvik have improved, and the lake bottoms in this area have been re-colonised. Salmon are once again swimming up the Mo river. The energy contained in the biogas replaces large quantities of fossil oil that was earlier used in manufacturing at the Domsjö fabriker.

Cross-media effects

The produced biogas substitutes fossil energy resources and thereby reduces fossil CO₂ emissions, and it finds a useful application of the waste water.

Driving force in implementation

Cleaner environment and biogas can be produced to replace fossil oil.

Economics

Recovers energy from waste water.

Reference plant

The biogas plant at Domsjö fabriker AB.

Position in the present BREF

Pos 2.2.1

4.6.3 *Norrmejerier, Sweden*

Description of the plant and of the technique

The Biotrans project includes:

- A biogas plant (anaerobic) to convert the wastewater into an energy source
- A heat pump to recover heat in the wastewater after the biogas plant
- An ultra-filtration plant for extraction of high-grade whey protein
- Changes in production, mainly increased cheese production

Whey and other products from cheese making are used as substrates to produce biogas at the dairy plant. In making cheese about 90% of the milk becomes whey. Traditionally whey is fed to animals. The whey is first ultra filtrated. With this method most of the proteins in the whey are removed by filtration. These proteins are used as a raw material in producing food products. Together with wastewater and other waste products, the remaining whey is anaerobically digested to produce biogas. The plant uses the Biotrans technology.

The substrate consists of whey from Norrmejerier dairy plants. The substrate is first passed through a hydrolysis chamber before it is pumped into the biogas reactor. The fat is then removed by flotation separation. This fat is digested separately in two mesophilic reactors with a retention time of 22 days. The remaining material is digested in a “contact process” in two reactors. This means that the effluent is returned to the process via sedimentation in a so-called “clarifier.” This maintains the density of bacteria in the reactor, which means that the retention time for the liquid can be kept short with no risk of loss of bacterial culture.

Applicability

The plant at Norrmejerier is the first plant in Sweden to use the Biotrans technology but probably many more will follow.

Cross-media effects

The Biotrans project has reduced energy consumption in the dairy due to:

- Steam production based on biogas
- Reduced steam consumption in the evaporator
- Heat production in the heat pump
- Reduced hot water demand
- The BOD and COD concentrations in the wastewater have been reduced by 90% and 80%, respectively

Driving force in implementation

The produced biogas replaces oil and is used to produce steam in a boiler. About 10,000 MWh of biogas is produced annually. A further 7,000 MWh is obtained in the form of heat from the effluent using a heat pump.

Economics

The total investment cost for the biogas plant including the filtration facility was 90 million SEK. The investment is expected to be repaid in 6 years thanks to energy savings and an improved use of raw materials.

Reference plant

Norrmejerier AB

Position in the present BREF

2.2.1

4.6.4 NSR biogas plant in Helsingborg, Sweden

Description of the plant and of the technique

The NSR biogas plant in Helsingborg started operations in 1996. NSR is a regional waste recycling company owned by six local authorities in north-west of Scania. The original driving force behind the development of the biogas plant was the need to treat various organic wastes that were unsuitable for landfilling.

Nowadays, the production and refinement of biogas as an alternative vehicle fuel is an additional motivation. Several improvements and extensions to the biogas production and distribution systems have been made since 1996. Upgrading of biogas started in 1997. Work on expanding the original biogas plant to double its capacity began in 2006 and was completed by the summer of 2007. The plant can now produce up to 5 million Nm³ of biogas per year. In 2011 a new plant for production of liquid biogas will be built.

A pipeline for biomanure was laid in 2006 to pump it directly out to the fields. The use of the pipeline saves about 550 truck transports per year which reduces CO₂ emissions with about 35 tonnes per year.

The facility receives primarily organic waste in the form of process waste from the food industry, fresh pig manure and source sorted food wastes as a main substrate. The substrate is digested in the reactors. The plant is designed to accept up to 80,000 tonnes per year of different kinds of waste, including waste that can be pumped, and source sorted and compressed food waste and packaged foods. Contracts with local farmers and food manufacturers ensure a constant supply of substrate to the plant. Two tanks, each 1000 m³ in size receive the waste. The waste is first chopped and mixed. The material is then pasteurized in three separate tanks at 70°C for one hour. The heat is supplied by a wood burning furnace. A compost filter removes odours during the pre-treatment. The one step process takes place in two mesophilic (37°C) reactors, each of 3,000 m³, with a retention time of 30 days. There is also an additional digestion chamber where material is stored prior to distribution.

There are two different upgrading plants: an old plant from 1997 using the PSA method, production capacity 350 Nm³/h, and a new plant from 2007 using the water wash technique, production capacity 650 Nm³/h. In 2009 the plant produced 3.3 million Nm³ of biogas.

Applicability

The method is based on well known processes and the size of the plant can be adapted continuously.

Cross-media effects

NSR has been innovative with respect to the distribution of bio-manure and was one of those responsible for the establishment of the certification system for bio-manure according to SPCR 120 regulations. The manure is pumped back through a 10 km long pipeline to 10 farmers that are participating in the project.

Driving force in implementation

Environmental benefits, CO₂ reduction and less consumption of fossil fuels and production of certified bio-manure. Reduction of landfilling and/or incineration of waste.

Economics

Income comes both from handling the organic material and from sale of biogas.

Reference plant

NSR AB

Position in the present BREF

Pos. 2.2.1

4.6.5 Svensk biogas AB, Sweden**Description of the plant and of the technique**

Svensk Biogas is a 100% owned subsidiary of Tekniska Verken i Linköping AB (publ), a municipal company owned by the city of Linköping.

In 2009 the production was 8.7 million Scm (Standard cubic metres) of gas.

The biogas train is example of the environmental benefits of biogas. The train was earlier driven on diesel, and the conversion to biogas has reduced emissions of greenhouse gases to near zero. Conversion to biogas was considerably cheaper than the alternative, which was to electrify the line between Linköping and Västervik.

It started with a pilot biogas project that was carried out between 1990 and 1994. Following an evaluation, a full-scale biogas plant was built at Åby, near Linköping, which started operating in spring 1997. The biogas was upgraded right from the beginning, to be used as a vehicle fuel for the city buses. The first public filling station in Linköping for biogas was opened in 2001, and several more have opened since. A number of improvements and extensions to the biogas plant and distribution system have been made since 1997, which have increased the

production and use of biogas. "Svensk Biogas i Linköping" was among the first in Sweden to upgrade biogas to vehicle fuel quality. Significant developments to the process have taken place during the eleven years the plant has been in operation. The biological process has been specially adapted to enable the digestion of a substrate comprising large amounts of slaughterhouse wastes that are rich in energy and proteins. Up to 1000 m³ of methane is extracted per tonne of organic material. The process has been stable for many years, despite high contents of nitrogen in the form of ammonium and a relatively high Tel Svensk Biogas has also received attention as a result of the biogas train (Amanda), which has been running between Linköping and Västervik since April 2006.

The substrate consists of about 55% of waste products from slaughterhouses and about 45% of other food wastes. The slaughterhouse waste is finely ground and mixed with the other substrates in a homogenizing tank. The substrate is then pasteurized by heating with steam to 70°C for one hour. The material is then cooled before it is pumped into the two reactors, each of which has a volume of 3,800 m³. Decomposition takes place at 38 C in a continuously mixed one-step process with a retention time of 30 days.

All the biogas produced at Åby is upgraded to use as a vehicle fuel. As early as 1992, some of the biogas produced at the local wastewater treatment plant was upgraded in a smaller plant (capacity 150 Nm³ biogas per hour) using the PSA technique. A new upgrading plant based on the water wash method opened in 1997. It has a capacity to upgrade 500 Nm³ biogas per hour. A third plant, using the same technique, was built in 2002, with a capacity of 1,400 Nm³ biogas per hour. Including the gas from the sewage treatment plant, approximately 65,000 MWh of upgraded biogas is produced each year, which supplies fuel to the town's buses, refuse lorries and a number of filling stations in the region.

After digestion, the bio-manure is cooled to 20 C and stored in a tank before being delivered to 30 farmers in the surrounding area. The bio-manure has a dry weight content of 4.2% and a nitrogen content of 6 kg per m³ and is certified according to SPCR 120. The bio-manure is spread with conventional techniques for liquid manure application.

Applicability

The method is based on well known processes and the size of the plant can be adapted continuously according to needs.

Cross-media effects

Generates both biogas for use in vehicles and certified bio-manure to farmers.

Driving force in implementation

The biogas plant in Linköping has been successively extended and improved to meet the continuously increasing demand in the region for renewable energy resources such as biogas. Total emissions of fossil carbon dioxide from vehicles have decreased in the Linköping area by more than 9,000 tonnes per year.

Economics

The biogas project will be economically profitable in the long term.

Reference plant

Swedish biogas AB, Linköping Sweden

Position in the present BREF

Pos. 2.2.1

4.6.6 Objects in the BREF – Emerging techniques**Ekoport Oy, Finland**

Description of the plant and of the technique. Ekoport Oy is commissioning a plant to produce diesel oil from Recovered Fuel (REF). The project is carried out in close co-operation with the regional waste management company LHJ Group in Forssa.

Diesel production is based on the German KDV technique. At the moment there are roughly ten reference plants established globally. Each plant is using more or less different sources of feedstock. In Forssa the feedstock is produced by LHJ Group's REF-plant which is located next to the Ekoport plant. It has been estimated that if 15,000–17,000 tonnes of waste is treated by the REF plant approximately 11,000 tonnes of REF is produced, and this amount can thereafter be converted to 5,000 tonnes of diesel oil with the KDV technique. The production capacity of the KDV plant is planned to be 500 litres/hour. The full scale annual production in Forssa will be approximately 5 million litres of diesel oil per year.

The process in KDV plant is based on catalytic depolymerization carried out in low pressure. Waste material is cracked forming a mixture of hydrocarbons, and then diesel oil is distilled out of the mixture. The steps of the whole production system are as follows:

- pre-treatment of solid municipal waste in a REF plant (REF 50–55% of the feed, particle size 10–20mm)
- REF is mixed with hot carrier oil (temp. 180 C), and water is removed by evaporation
- the mixture is injected into turbines where the reactions happen in a temperature of 280–300°C
- diesel oil distilled out in a temperature of 260°C
- lighter and heavier fractions are recycled back to the process

The process is in low pressure (less than 1 bar pressure). Energy for the plant is produced in a separate CHP unit consuming 10% of the energy content of the product. Besides diesel oil other fractions are: bottom ash, salt containing water and exhaust fumes from the generators.

Applicability

The method is globally adapted to different situations. Input materials differ and include e.g. the following: household waste, waste from agriculture, bituminous waste, plastic waste, car tyres, bilge oils, wood chips.

Environmental impact and benefits, energy efficiency

Recovery of the energy content of municipal waste with low gaseous emissions. The process is self sufficient with regard to energy.

Cross-media effects

The produced diesel substitutes imported fossil fuels. The process produces bottom ashes amounting to 2–13% of the feed.

Driving force in implementation

Alternative to waste-to-energy plants, enables local and relatively small scale fuel production, replaces imported fuels.

Economics

Income from sale of diesel oil.

Reference plant

Ekoport Turku Oy, KDV-plant, Forssa, Finland

Position in the present BREF

Pos. 2.5.2

4.7 Treatment operations for disposal

4.7.1 *Objects in the BREF – Established techniques*

4.7.2 *Objects in the BREF – Emerging techniques*

Smedlund Environmental systems AB, Sweden

Description of the plant and of the technique. Smedlund environmental systems AB is an innovation company that develops products for the treatment of food waste. Somnus is a new system for dry conservation of food waste. The pilot plant in Gothenburg has worked very well so the product is expected to be on the market in 2012.

The drying process needs some energy. A Somnus machine dimensioned for 200 households consumes 6,750 kWh per year. If this is divided per household it corresponds to a television set in standby position. The energy that can be recovered from the dry conserved waste from 200 households is about 45,000 kWh per year.

Somnus is a new system for drying organic household waste. The organic waste is very much reduced in weight and volume by dry conservation. Both energy and nutrients are preserved in the waste and are available for production of biogas as well as for soil improvement purposes. The pilot test system that has been used in Gothenburg since 2007 has worked very well.

Dry conservation gives:

- A dry odour free easy to handle material
- Reduction of weight and volume by about 75%
- Reduced need for waste transportation from 52 to 2 times per year
- Soil improvement agent rich in nutrients
- Motivation and understanding from the households to separate household waste
- Automatic collection without the need to handle a dustbin
- No destructive leachate water in the garbage truck
- A material with a more neutral pH that is possible to store in central treatment facilities

The development of an in-house solution is underway and is expected to reach the market in 2012.

Applicability

This is a new and promising technology.

Environmental impact and benefits, energy efficiency

The drying process needs some energy. A Somnus machine dimensioned for 200 households consumes 6,750 kWh per year. The energy that can be recovered from the dry conserved waste from 200 households is about 45,000 kWh per year.

The material is both easy to handle and easy to store and therefore it is expected to be attractive on the biological waste market.

Cross-media effects

Converts organic waste into storageable merchandise.

Driving force in implementation

Less need for transportation gives reduced CO₂ emissions. The material is odourless and gives about 4 to 5 times as much energy per weight unit compared to traditionally collected "wet" raw material.

Economics

The product is in its final stage of development. This technology gives economic as well as environmental benefits.

Reference plant

Smedlund Miljösystem AB

Position in the present BREF

Not included

5. Evaluation of the objects

A common feature of the objects presented in this document is the move in the waste treatment industries away from seeing waste only as a disposal problem and instead view it as a resource for raw material recovery and/or energy production. The identified and presented objects represent a wide range of innovative and proven waste treatment technologies developed and implemented in the Nordic countries using a variety of different waste sources as input materials.

The objects presented under biological treatment focus on methods to generate renewable and CO₂ neutral energy from a variety of organic waste types generated by households or industry together with the production of an end product, which could be used as a fertilizer and/or a soil conditioner. This is not a new technique in waste treatment, but the presented objects show how this technique has been developed further and become more specialized and efficient.

Objects presented under the physico-chemical treatment and under other treatment operations represent a variety of new techniques enabling raw materials reclamation thereby substituting the use of virgin materials. At the same time environmental benefits are achieved by reducing the need for disposal of waste, e.g. by landfilling, incineration or discharge by sewage. A common feature of these objects is the reduced carbon footprint associated with the production of “secondary” raw materials and products.

Several objects presented under treatment operations for energy recovery could be observed as the second generation of biological treatment techniques enabling the production of “green” fuel based on different types of organic waste, which can be utilized in the transportation sector. Environmental benefits will primarily be the possibility of substituting the use of fossil fuels and thereby reduce CO₂ emissions.

A common feature of the presented objects is that they are economically lucrative and that the driving forces for implementation in most cases are reduced environmental impacts combined with enhanced energy efficiency. Also an increased productivity in some cases has been of major importance.

6. Conclusions

In this project a total of 29 out of 57 objects identified have been selected to be good Nordic examples of BAT for the Waste Treatment Industries. 20 of the objects are not covered in the present BREF in question but now covered by the IED directive.

The project covered one progress report and one intermediate report. Cooperation with the industries was working very well and the Nordic BAT-group as a steering group has given the needed support to the study.

The results of this study are of great importance as a supporting material for the future update of the BREF for Waste Treatment Industries and are of great importance for the Nordic countries to be represented in the coming work.

The comments given in the study show the need to update the present BREF and include the new industries covered by the IED directive. With this contribution the BREF document will act as a guideline for both industries and authorities in Europe.

7. Danish Summary – Sammenfatning

Nordisk Ministerråd har via HKP-gruppen (Bæredygtig Konsumtion og Produktion) i samarbejde med NAG-gruppen (Nordisk Affaldsgruppe) besluttet at udføre en nordisk undersøgelse om gode BAT-teknikker for at reducere miljøpåvirkningen fra forskellige affaldshåndteringsindustrier. En arbejdsgruppe (BAT-gruppe) har på vegne af NAG-gruppen været styregruppe på projektet.

Målet med denne undersøgelse er at understøtte den fremtidige opdatering af det nuværende BREF dokument fra 2006 omhandlende affaldshåndteringsindustrier. Det praktiske arbejde er udført af Rambøll med konsulenter i tæt samarbejde med den nordiske BAT-gruppe med Rambøll Danmark A/S som ledende konsulent.

Undersøgelsen gjorde det klart, at der er adskillige teknologier, processer m.v. på BAT-niveau, som allerede er implementerede i affaldshåndteringsindustrien i de nordiske lande. Disse industrier blev også inddraget i udførelsen af studiet. Målet var at identificere ca. 60 industrier og derefter udvælge og detaljeret beskrive ca. 30 relevante industrier.

Ud af i alt 57 identificerede industrier, er 49 klassificeret som "Etablerede teknikker" og 8 er klassificeret som "Nye teknikker." Alle industrier blev screenet for miljø- og klimamæssige påvirkninger, og 29 blev udvalgt ud fra de resultater, de har opnået.

8. Appendix 1

Reference of the objects

8.1 Biological treatment

The following plants have been identified:

8.1.1 *Objects in BREF – Established techniques*

Ecopro AS, Norway

Reference plant

Ecopro AS
Russerveien 10
NO-7650 Verdal
Norway
Ph +47 74 07 52 22
Fax +47 74 07 55 20
odin.krogstad@ecopro.no
www.ecopro.no

Title of the object

Biological treatment of sludge and organic waste from households and professionals by Cambi process. The waste is treated in a closed plant. Pre-treatment is followed by hygienisation, treatment in bio reactor where methane is removed, then followed by composting and final maturation.

Motivation

Reduces landfill disposal in accordance with landfill directive and recycles humus and nutrients as compost products. Produces an energy product that can be transported for use outside the plant.

Practice

Established technique.

Comment

Capacity 45,000 tonnes per year. Norway's largest plant for biogas production from organic household waste. The plant has been on the market from 2008. Odour must be managed carefully.

Position in the present BREF

Not included.

IVAR IKS, Norway**Reference plant**

IVAR IKS
Breiflåtveien 16/18
NO-4069 Stavanger
Norway
Tel +47 51 90 85 00
Fax +47 51 90 85 01
ivar@ivar.no
www.ivar.no

Title of the object

Hogstad composting plant. Indoor composting of organic household waste from food and gardening. Odour treatment is part of the plant.

Motivation

Reduces landfill disposal in accordance with landfill directive and recycles humus and nutrients as compost products.

Practice

Established technique.

Comment

Capacity 30,000 tonnes per year. In operation from year 2000.

Position in the present BREF

Not included.

Lindum AS, Norway**Reference plant**

Lindum AS
Lerpeveien 155
NO-3036 Drammen

Norway
Tel +47 32 21 09 00
Fax +47 32 21 09 15
post@lindum.no
lindum.no

Title of the object

Indoor composting of organic waste.

Motivation

Reduces landfill disposal in accordance with landfill directive and recycles humus and nutrients as compost products.

Practice

Established technique.

Comment

Odour must be managed carefully.

Position in the present BREF

Not included.

Mjøsanlegget AS, Norway

Reference plant

Mjøsanlegget AS
Åsmarkvegen 301
NO-2614 Lillehammer
Norway
Tel +47 61 27 05 60
Fax +47 61 26 91 26
Tom.werven@glor.no
www.glor.no

Title of the object

Biological treatment of organic waste by the Cambi process. The waste is treated in a closed plant. Mechanical pretreatment is followed by hygienisation, then treatment in bio reactor where methane is removed, then followed by composting and final maturation.

Motivation

Reduces landfill disposal in accordance with landfill directive and recycles humus and nutrients as compost products. Produces an energy product that can be transported for use outside the plant.

Practice

Established technique.

Comment

Odour must be managed carefully.

Position in the present BREF

Not included.

Biovækst, Denmark**Reference plant**

BioVækst A/S, Denmark
Vadsby Stræde 6
DK-2640 Hedehusene
Tel +45 4399 5020
Fax +45 4399 5231
info@solum.com
www.biovaekst.dk

Title of the object

Anaerobic digestion of source separated household waste, organic waste from industries and sludge producing biogas and fertiliser/soil conditioning agent.

Motivation

Reduction of CO₂ emissions.

Practice

Established technique.

Comment

Using the Aikan technology. Capacity approx. 18,000 tonnes/y.
Similar facility in Norway with capacity approx. 30,000 tonnes/y.

Position in the present BREF

Pos. 2.2.1.

KomTek Miljø A/S, Denmark

Reference plant

KomTek Miljø A/S, Denmark
Drivervej 8
DK-6670 Holsted
Tel +45 70205489
Fax +45 75391111
mail@komtek.dk
www.komtek.dk

Title of the object

Composting of organic waste from households, Waste Water Treatment, garden and park maintenance, food industries and farming.

Motivation

The practice is working very reliably. Reduces landfill disposal in accordance with the landfill directive and recycle humus and nutrients as compost products.

Practice

Established technique.

Comment

Capacity 40,000 tonnes/y

Position in the present BREF

Not included

Odense Nord Miljøcenter, Denmark

Reference plant

Odense Nord Miljøcenter, Denmark
Strandløkkevej 100
DK-5270 Odense N
Tel +45 63189000
Fax +45 66189069
info@odenserenovation.dk
www.odenserenovation.dk

Title of the object

Composting of organic waste from Waste Water Treatment and garden and park maintenance.

Motivation

The practice is working very reliably. Reduces landfill disposal in accordance with the landfill directive and recycle humus and nutrients as compost products.

Practice

Established technique.

Comment

Capacity 60,000 tonnes/y.

Position in the present BREF

Not included.

CompSoil Danmark Aps, Denmark**Reference plant**

CompSoil Danmark Aps, Denmark

Overgård Gods

Overgaardsvej 28

DK 8970 Havndal

Tel +45 70207887

Fax +45 70207886

pev@compsoildanmark.com

www.compsoil.dk

Title of the object

Composting of organic waste from Waste Water Treatment and garden and park maintenance.

Motivation

The practice is working very reliably. Reduces landfill disposal in accordance with the landfill directive and recycle humus and nutrients as compost products.

Practice

Established technique.

Comment

Capacity 70,000 tonnes/y.

Position in the present BREF

Not included.

Envor Biotech Oy, Finland

Reference plant

Envor Biotech Oy
Voimalankatu 56
30420 Forssa, Finland
Tel +358 3 412 4251
Fax +358 3 412 4260
www.enwor.fi

Title of the object

Anaerobic digestion of source separated biodegradable household waste, bio-waste from industries and sludge producing biogas and soil improving products/ compost.

Motivation

Economical way for the treatment of bio-wastes, reduction of greenhouse gas emissions.

Practice

Established technique.

Comment

The process is based on anaerobic digestion. The capacity of the facility is 56,000 tonnes/year which is converted to 4 million m³ of biogas. Third line with capacity of 28,000 tonnes/y is under construction.

Position in the present BREF

Pos. 2.2.1.

VamBio Oy, Finland

Reference plant

VamBio Oy, Finland
Wahreninkatu 11, 30100, Forssa
Tel +358 50 525 4222
www.vambio.fi

Title of the object

Anaerobic digestion of bio-wastes from industries, agriculture, sewage treatment.

Motivation

Reduction of greenhouse gas emissions and production of energy and fertilizers.

Practice

Established technique.

Comment

The plant is in Vampula, Finland. Technology supplier is Watrec Oy, Finland. The annual biogas production capacity of the plant is approximately 2.6 million m³.

Position in the present BREF

Pos. 2.2.1.

Pirkanmaan Jätehuolto Oy, Finland**Reference plant**

Pirkanmaan Jätehuolto Oy, Finland
Tarastijärvi waste treatment center
Tarastijärventie 66
Tampere
Tel +358 3 360 0393
www.pirkanmaan-jatehuolto.fi

Title of the object

Treatment of household bio-waste by composting.

Motivation

Reduction of greenhouse gas emissions and production of compost for landscaping purposes.

Practice

Established technique.

Comment

Plant started its operation in 2004. The annual input capacity of the plant is 12,000 tonnes.

Position in the present BREF

Not included

Biovakka Suomi Oy, Finland

Reference plant

Biovakka Suomi Oy, Finland
Vehmaa
Kalannintie 191
23200 Vinkkilä
Tel +358 20 741 9000
www.biovakka.fi

Title of the object

Anaerobic digestion of bio-wastes from industries, agriculture, sewage treatment.

Motivation

Reduction of greenhouse gas emissions and production of energy and fertilizers.

Practice

Established technique.

Comment

The capacity of the plant is 120,000 tonnes of bio-waste per year.

Position in the present BREF

Pos. 2.2.1.

Lakeuden Etappi Oy, Finland

Reference plant

Lakeuden Etappi Oy
Laskumäentie 15
60760 Pohjanluoma (Ilmajoki)
Tel +358 6 4214900
Fax (06) 4214999
www.etappi.fi

Title of the object

Anaerobic digestion of bio-wastes from industries, agriculture, sewage treatment.

Motivation

Reduction of greenhouse gas emissions and production of energy and fertilizers.

Practice

Established technique.

Comment

Production started in 2008. Input capacity of the plant is 55,000 tonnes of waste per year.

Position in the present BREF

Pos. 2.2.1.

8.1.2 Objects in BREF – Emerging techniques**St1 Biofuels Oy, Finland****Reference plant**

St1 Biofuels Oy
P.O.B. 100, FIN-00381 Helsinki
Finland
Tel 358 (0)10 557 2375
www.st1.eu

Title of the object

Production of bioethanol from bio-wastes using the Bionolix™ technology.

Motivation

Reduction of CO₂ emissions.

Practice

Emerging technique.

Comment

The annual production of the facility is approximately 1 million litres of bioethanol. The plant is under commissioning.

Position in the present BREF

Pos. 2.5.2.

8.2 Physico chemical treatment

8.2.1 *Objects in BREF – Established techniques*

Ecopro AS, Norway

Reference plant

Ecopro AS
Russerveien 10
NO-7650 Verdal
Norway
Ph +47 74 07 52 22
Fax +47 74 07 55 20
odin.krogstad@ecopro.no
www.ecopro.no

Title of the object

Biological treatment of sludge and organic waste from households and professionals by Cambi process. The waste is treated in a closed plant. Physico chemical pre-treatment followed by hygienisation, treatment in bio reactor where methane is removed, then followed by composting and final maturation.

Motivation

Reduces landfill disposal in accordance with landfill directive and recycles humus and nutrients as compost products. Produces an energy product that can be transported for use outside the plant.

Practice

Established technique.

Comment

Capacity 45,000 tonnes per year. Norway's largest plant for biogas production from organic household waste. The plant has been on the market from 2008. Odour must be managed carefully.

Position in the present BREF

Not included.

Glasitt AS, Norway**Reference plant**

Glasitt AS
Bismo industriområde
NO-2690Skjåk
Norway
Tlph +47 6121 36 50
Fax +47 6121 36 51
logmein@glassgjenvinning.no
www.glassgjenvinning.no

Title of the object

Physical treatment of glass from food packaging and drinks packaging, producing foam glass – a recycled product used for insulation and drainage purposes.

Motivation

Reduces landfill disposal in accordance with the landfill directive. Reduces the need for non-renewable virgin resources and saves energy.

Practice

Established technique.

Comment

Dust, noise and vibrations have to be managed carefully.

Position in the present BREF

Not included.

Gypsum Recycling A/S, Denmark**Reference plant**

Gypsum Recycling International A/S, Denmark
Egebækgård
Egebækvej 98
DK-2850 Nærum
Tel +45 7022 1730
Fax +45 4556 9365
gr@gipsrecycling.dk
www.gipsrecycling.dk

Title of the object

Recycling of gypsum from construction and demolition waste (gypsum boards).

Motivation

The practice is working very reliably. Reduces landfill disposal and use of virgin raw materials.

Practice

Established technique.

Comment

Capacity to treat all generated gypsum waste in Denmark, approx. 65,000 tonnes/y. Currently approx. 80% of this gypsum waste is collected and treated at the plant.

Position in the present BREF

Pos. 2.3.3.3.

Peterson Linerboard AS, Norway**Reference plant**

Peterson Linerboard AS
Ranheim
NO-7492 Trondheim
Norway
Tlph +47 815 30 444
Fax +47 73 57 75 01
kundeservice@peterson.no
www.peterson-emballasje.no

Title of the object

Physical and mechanical treatment of used corrugated cardboard recycling it into new corrugated cardboard, paper bags, fish boxes and drinking cups.

Motivation

Brings used materials back into production. Reduces the need for virgin resources (wood) and energy.

Practice

Established technique.

Comment

Plant is in Trondheim, while main office is in Sarpsborg. Capacity 140 tonnes per year. Very high recycling efficiency.

Position in the present BREF

Not included.

Remiks Miljøpark AS, Norway**Reference plant**

Remiks Miljøpark AS
Postboks 2509/ Ringvegen 120
NO-9270 Tromsø
Norway
Tlph +47 77 60 19 00
Fax +47 77 60 19 01
post@remiks.no
www.remiks.no

Title of the object

Optic detection and mechanical sorting of household waste that has been source separated into plastic bags in up to six categories, each bag with a different colour.

Motivation

Efficient waste sorting. A process that gives room for a more simple and efficient multiphase solution for collecting household waste.

Practice

Established technique.

Comment

The plant receives bags of sorted household waste from both small containers and vacuum systems.

Position in the present BREF

Not included.

TH Paulsen AS, Norway**Reference plant**

TH Paulsen AS
Lønningshaugen 12

NO-5258 Blomsterdalen
Norge
Tlph +47 55 27 70 90
Fax +47 55 27 70 91
bedrift@bir.no
www.bir.no/thpaulsen/

Title of the object

Fully automatic sorting of mixed paper and cardboard waste by Titech technology. Many different paper and cardboard categories are detected by scanning and each item pneumatically shot out from the main waste stream and into a separate stream for its category.

Motivation

Increases recycling and improves the purity, precision and cost effectiveness when sorting waste fractions.

Practice

Established technique.

Comment

Capacity 60,000 tonnes per year. This technology can also be used for other categories of waste.

Position in the present BREF

Not included.

WEEE Recycling AS, Norway

Reference plant

WEEE Recycling AS
Øysand Næringspark
NO-7224 Melhus
Norway
Tlph +47 72 85 72 20
Fax +47 72 85 72 29
info@weee.no
www.weee.no

Title of the object

Mechanical separation and fragmentation of waste from electric and electronic products into metals and plastic bulk materials for further recycling.

Motivation

Prohibiting leakage of pollutants into the environment. Bringing non renewable materials – metals and fossil materials – back into industrial production. Reducing the need for non-renewable virgin resources.

Practice

Established technique.

Comment

Capacity 42,000 items of refrigeration equipment per year. Very high recycling efficiency. One of the most modern plants for recycling EEE waste and refrigeration equipment.

Position in the present BREF

Not included.

Gamle Mursten, Denmark**Reference plant**

Gamle Mursten ApS. (Old Clean Bricks ApS.), Denmark
Skotlandsvej 16
DK-5700 Svendborg
Tel +45 6221 1416
ocb@gamlemursten.dk
www.gamlemursten.dk

Title of the object

Cleaning and reuse of old tile bricks.

Motivation

Reduction of CO₂ emissions.

Practice

Established technique.

Comment

Plant established with capacity of 2,000–4,000 bricks/hour. Cleaning of 2,000 bricks saves approx. 1 tonne of CO₂. The only facility in Denmark.

Position in the present BREF

Pos. 2.3.3.3.

Genan A/S, Denmark

Reference plant

Genan A/S, Denmark
Jeginøvej 16
DK-8800 Viborg
Tel +45 8728 3000
Fax +45 8728 3030
genan@genan.eu
www.genan.eu

Title of the object

Recycling of spent tyres from vehicles.

Motivation

The practice is working very reliably. Reduces landfill disposal in accordance with the landfill directive and saves the use of virgin raw materials.

Practice

Established technique.

Comment

Receives approx. 90% of spent tyres in Denmark. New facilities in Germany and the US. Goal to cover 10% of world market.

Position in the present BREF

Pos. 2.3.3.3.

Shark Solutions A/S, Denmark

Reference plant

Shark Solutions A/S, Denmark
Katrinedal 7
DK-4520 Svinninge
Tel +45 5926 1590
Fax: +45 5926 1790
partner@shark-solutions.dk
www.shark-solutions.com

Title of the object

Glass recycling system designed for laminated glass producing glass cullet and a PVB fraction for recycling.

Motivation

Reduces landfill disposal and reduces consumption of virgin raw materials.

Practice

Established technique.

Comment

Mobile and stationary systems in operation.

Position in the present BREF

Pos. 2.3.3.3.

Novopan Træindustri A/S, Denmark**Reference plant**

Novopan Træindustri A/S, Denmark

Fabriksvej 2, Pindstrup

DK-5550 Ryomgård

Tel +45 8974 7474

Fax +45 8974 7496

novopan@novopan.dk

www.novopan.dk

Title of the object

Processing of “clean” wood waste to be used as a raw material for the production of chip boards.

Motivation

The practice is working very reliably. Uses waste wood instead of virgin raw materials.

Practice

Established technique.

Comment

One facility covers the need for the whole of Denmark.

Position in the present BREF

Pos. 2.3.3.3.

Kommunekemi A/S, Denmark**Reference plant**

Kommunekemi A/S, Denmark

Lindholmvej 3
DK-5800 Nyborg
Tel +45 6331 7100
Fax +45 6331 7300
kk@kommunekemi.dk
www.kommunekemi.dk

Title of the object

Reprocessing of ashes from power plants fuelled with straw.

Motivation

Reclamation of potassium to be used as a fertiliser. Reduced consumption of virgin raw materials.

Practice

Established technique.

Comment

Pilot plant established and in operation.

Position in the present BREF

Pos. 2.3.3.15.

Frandsen Industri, Denmark

Reference plant

Frandsen Industri, Denmark
Bakkegårdsvej 2
DK-9620 Aalestrup
Tel +45 9851 1966
Fax +45 9851 1909
info@frandsenindustri.dk
www.frandsenindustri.dk

Title of the object

Recycling of plastic fishing nets.

Motivation

Reduces landfill disposal and virgin raw material consumption. Reduction of CO₂ emissions when used as a raw material for production of new plastic products.

Practice

Established technique.

Comment

Innovative method for separation of different types of plastic.

Position in the present BREF

Pos. 2.3.3.3.

8.2.2 Objects in BREF – Emerging techniques**BlackCarbon A/S, Denmark****Reference plant**

BlackCarbon A/S, Denmark

Barritskov

Barritskovej 36

DK 7150 Barrit

Tel +45 75691177

info@blackcarbon.dk

www.blackcarbon.dk

Title of the object

Converts biomass into biochar through pyrolysis, releasing bio energy in the process.

Motivation

Reduces landfill disposal in accordance with the landfill directive and recycles biochar as a soil improver.

Practice

Emerging technique.

Comment

Plant construction is ongoing. Capacity 750 tonnes/y.

Position in the present BREF

Pos. 2.3.3.2.

8.3 Other treatment operations

8.3.1 *Objects in BREF – Established techniques*

Hedinn hf., Iceland

Reference plant

Hedinn
Gjahella 4
221 Hafnarfjordur, Iceland
Tlph +354 569 2100
www.hedinn.is

Title of the object

Small-scale factory for production of fish meals and fish oils from fish by-products (defined as waste, if not treated for use).

Motivation

Small size, improved technique, energy efficiency, by-products treated fresh at the source.

Practice

Established technique.

Position in the present BREF

Not included.

Akkuser Oy, Finland

Reference plant

Akkuser Ltd
Alasintie 8, P.O. BOX 45
85500 NIVALA
FINLAND
Tel +358-50-3120 591
Fax +358-8-44 33 89
www.akkuser.fi

Title of the object

Recycling of batteries and accumulators using Dry Technology™.

Motivation

High recycling rate of metals, low energy consumption and less CO₂ emissions compared to alternative methods like foundry technology.

Practice

Established technique.

Comment

The process is based on AkkuSer's patented method "Dry Technology."
Capacity of the plant is 4,000 tonnes/y.

Position in the present BREF

Not included

Cool Finland Oy, Finland

Reference plant

Cool Finland Oy, Finland

Kiimassuontie 127

FI-30420 Forssa

Tel +358 440 242 700

Fax + 358 3 424 2630

www.cool-finland.fi

Title of the object

Recycling of refrigeration equipment containing CFC compounds.

Motivation

Recovery of CFC compounds and recyclables.

Practice

Established technique.

Comment

The capacity of the facility in Forssa is approx. 11,000 tonnes/y. The process equipment supplier of the facility is SEG Umwelt-Service GmbH.

Position in the present BREF

Pos. 2.4

Isfelag Vestmannaeyja, Iceland**Reference plant**

Isfelag Vestmannaeyja

Strandvegur 28
900 Vestmannaeyjar, Iceland
Tlph +354 488 1100
www.isfelag.is

Title of the object

Fish processing plant – Recovery of by-products from process water.

Motivation

Economical solution, environmental benefits, improved company image.

Practice

Established techniques.

Position in the present BREF

Not included.

L&T Recoil Oy, Finland

Reference plant

L&T Recoil, Finland
Paksuniementie 15–17
FI-49460 Hamina, Finland
Tel +358 5 2353 800
Fax +358 5 230 2330
www.lt-recoil.com

Title of the object

Re-refining of used lubricating oils into new base oils by using fractionation and the hydrofinishing technology.

Motivation

Conservation of natural resources.

Practice

Established technique.

Comment

Plant capacity is 60,000 tonnes/y of used lubricating oils producing base oils and fuel oil and bitumen.

Position in the present BREF

Pos. 2.4.1.

Muovix Oy, Finland**Reference plant**

Muovix Oy, Finland
Kynttilätie 4
11710 Riihimäki
Tel + 358 19 760 420
Fax + 358 19 760 4211
www.muovix.fi

Title of the object

Recycling of plastic waste into plastic profiles for construction purposes.

Motivation

Material recovery with production of saleable products.

Practice

Established technique.

Comment

The annual input of plastic waste in Riihimäki plant is approximately 8,000 tonnes of mixed plastic wastes per year.

Position in the present BREF

Not included

Primex ehf, Iceland**Reference plant**

Primex
Oskarsgata 7
589 Siglufjörður, Iceland
Telph +354 460 6900
www.primex.is

Title of the object

Chitosan processing plant.

Motivation

Reduces the environmental impact of shrimp shell waste.

Comment

Established technique

Position in the present BREF

Not included.

Onni Forsell Oy, Finland**Reference plant**

Onni Forsell Oy, Finland

Jussilantie 5

05200 RAJAMÄKI

Tel +358 9 276 6980

Fax +358 9 290 3138

www.onniforsell.fi

Title of the object

Recycling of barrels and IBC packages.

Motivation

Conservation of natural resources and reduction of the CO₂ emissions in barrel production.

Practice

Established technique.

Comment

Capacity of the plant is 250,000 barrels/y and 40,000 IBC containers/y.

Position in the present BREF

Pos. 2.1.9.

Ekokem Oy Ab, Finland**Reference plant**

Ekokem Oy Ab

P.O. BOX 181

FIN-11101 Riihimäki, Finland

Tel +358 10 7551 000

Fax +358 10 7551 217

e-mail: export(at)ekokem.fi

www.ekokem.fi

Title of the object

Physico-chemical treatment of fluorescent tubes.

Motivation

Reduction of environmental risks. Treatment of mercury containing hazardous waste in controlled conditions.

Practice

Established technique.

Comment

The plant has an annual capacity of 5 million fluorescent tubes.

Position in the present BREF

Pos. 2.1.10.

8.3.2 Objects in BREF – Emerging techniques**ZenRobotics Ltd, Finland****Reference plant**

ZenRobotics Ltd., Finland
Mikonkatu 8 A 8th floor
FI-00100 Helsinki
Tel +358 45 259 6161
Fax +358 10 296 0311
www.zenrobotics.com

Title of the object

A robotic waste sorting system.

Motivation

Improved pre-treatment of mixed waste in the production of recyclables.

Practice

Emerging technique.

Comment

Zen Robotics Ltd and SITA Finland Oy Ltd are launching the first Zen-Robotics Recycler™ system.

Position in the present BREF

Pos. 2.4.

8.4 Treatment operations for energy recovery

8.4.1 *Objects in BREF – Established techniques*

DAKA Biodiesel Production, Denmark

Reference plant

DAKA Biodiesel Production a.m.b.a., Denmark
Dakavej 6
DK-8723 Løsning
Tel +45 5156 4601
ka@daka.dk
www.dakabiodiesel.dk

Title of the object

Processing waste products from the agricultural sector (animal byproducts) producing biodiesel.

Motivation

Reduction of CO₂ emissions.

Practice

Established technique.

Comment

Plant capacity 55 million l/y and prepared for enlargement up to 100 million l/y.

Position in the present BREF

Pos. 2.5.2.5 (currently only vegetable waste).

NSR biogas plant in Helsingborg, Sweden

Reference plant

NSR AB
Hjorthögsvägen 1
251 89 Helsingborg
Finland
Tel +46 42 400 13 00
nsr@nsr.se
www.nsr.se

Title of the object

Production of biogas and certified manure

Motivation

Biogas to the gas grid and piped bio manure to farmers

Practice

Established techniques

Comment

Initiator of the bio manure certification system according to SPCR I20 regulations. Reduction of CO₂ emissions.

Position in the present BREF

Pos. 2.2.1

Domsjö fabriker, Sweden**Reference plant**

Domsjö Fabriker AB
891 86 Örnköldsvik
Sweden
Tel.vx 0660-756 00
www.domsjoe.com

Title of the object

The largest producer of biogas in Sweden.

Motivation

The plant uses wastewater from the biorefinery Domsjö fabriker and from nearby chemical plants Akzo Nobel and Sekab which has resulted in much discharge from these factories.

Practice

Established techniques

Comment

The efficient biological treatment of industrial wastewaters has resulted in much cleaner discharges from the factories. The energy in the biogas replaces large quantities of fossil oil.

Position in the present BREF

Pos. 2.2.1

Henriksdal waste water treatment plant, Sweden

Reference plant

Henriksdal waste water treatment plant
Stockholm Vatten AB
106 36 Stockholm
Sweden
Tel+4608-522 120 00
stockholmvatten@stockholmvatten.se
www.stockholmvatten.se

Title of the object

Co-digestion of waste.

Motivation

Combination of new and conventional technology in a new concept.

Practice

Established technique

Comment

Henriksdal waste water treatment plant is increasing its capacity to receive external organic waste. The waste is received in a new waste reception station with a capacity of 50,000 tonnes per year.

Position in the present BREF

Pos. 2.2.1

Linköping biogas plant, Sweden

Reference plant

Svensk Biogas i Linköping AB
Åby Västergård 3
Box 1500
581 15 Linköping
Sweden
Tel +46 13-20 80 60
info@svenskiogas.se
www.svenskiogas.se

Title of the object

Production of biogas

Motivation

Effective biogas production with high methane yield and the biogas train Amanda

Practice

Established technique

Comment

Optimized process which made the building of a third reactor obsolete. The biogas train Amanda – a unique train that was earlier driven on diesel. The train was converted to biogas because it was cheaper than to electrify the line.

Position in the present BREF

Pos. 2.2.1

Norrmejerier biogas plant, Sweden**Reference plant**

Norrmejerier
Mejeriv. 2
906 22 Umeå
Sweden
Tel 090-18 28 00
www.norrmejerier.se

Title of the object

Uses whey to produce biogas

Motivation

Uses the waste product whey to produce biogas to replace fossil oil. Reduces CO₂ emissions.

Practice

Established technique

Comment

Whey and other waste products from cheese-making are used as substrates for biogas production. The Biotrans plant at Norrmejerier is the first in Sweden that makes effective use of whey.

Position in the present BREF

Pos. 2.2.1

Uppsala biogas plant, Sweden

Reference plant

Uppsala Vatten och Avfall AB
Box 1444
751 44 Uppsala
Sweden
Tel +46 18-727 94 00
www.uppsalavatten.se

Title of the object

Effective recovery of waste.

Motivation

Use of both solid and liquid waste in the process.

Practice

Established technique

Comment

Effective recovery of incoming waste in a wet recirculating process. The decomposition results in 12 mm particles.

Position in the present BREF

Pos. 2.2.1

Västerås biogas plant

Reference plant

Svensk växtkraft AB
721 87 Västerås
Sweden
Tel +46 21-39 35 00
www.vafabmiljo.se

Title of the object

The “mechanical cow”

Motivation

A biogas plant that digests both agricultural crops and household organic waste in the same process.

Comment

Many farms in the area have no animals so their soils do not receive manure. So instead of using supply nutrients from mineral fertilizer the farmers now can use the manure from the biogas plant. The biogas plant is an important component of a complete system for recycling raw materials, waste, nutrients and energy.

Position in the present BREF

Pos. 2.2.1

Örebro biomethane plant, Sweden**Reference plant**

Swedish Biogas International AB

Gjuterigatan 1B

582 73 Linköping

SWEDEN

Tel +46 13 465 08 85

<http://www.swedishbiogas.com/index.php/sv/referensanlaeggningar/sverige/oerebro>

Title of the object

Effective and newly built

Motivation

Crop based raw material and waste products from food processing industry are used as substrate.

Practice

Established technique

Comment

Produces both 6 million Nm³/year of biogas and 45,000 m³ of biofertilizer. The process is coordinated with the process at Skebäck waste water treatment plant in Örebro.

Position in the present BREF

Pos. 2.2.1

ÅCA, Åland**Reference plant**

Ålands Centralandelslag, ÅCA

Drittel-Mattesgränd 7
AX 22 150 JOMALA
ÅLAND
www.aca.ax

Title of the object

Production of biogas

Motivation

Production of biogas from whey, milk and wastewater. Reduction of CO₂ emissions.

Practice

Established technique

Comment

Reduces waste transportation from the dairy with about 70,000 km/year.

Position in the present BREF

Pos 2.2.1

EwaPower Ab Oy, Finland

Reference plant

EwaPower Ab Oy
Lautnitsaarentie 90
68600 Pietarsaari
Tel +358 6 322 7200
Fax +358 6 322 7201

Title of the object

Production of pellets from RDF/REF.

Motivation

Improvement of the quality of recovered waste.

Practice

Established technique.

Comment

Pellet production since 1996. The annual input capacity of the plant is 25,000 tonnes of waste where 56% can be converted to pellets.

Position in the present BREF

Pos. 2.5.1.1.

Lassila & Tikanoja Oy, Finland**Reference plant**

Lassila & Tikanoja Oy, Finland

Savio waste treatment area

Karhuntassuntie 59

004260 Kerava

Tel +358 50 385 7485

www.lassila-tinkanoja.fi

Title of the object

Production of recovered fuel (REF) from waste and by-products from industries.

Motivation

Reduction of greenhouse gas emissions.

Practice

Established technique.

Comment

The plant is being renovated and will have a capacity of 230,000 tonnes per year. New line for the production of solid biofuels started in 2010.

Position in the present BREF

2.5.1.

Oy Stormossen Ab, Finland**Reference plant**

Oy Stormossen Ab, Finland

Stormossenintie 56

66 530 Koivulahti

Tel + 358-(0)6-322 7200

Fax. +358-(0)6-322 7201

info@stormossen.fi

www.stormossen.fi

Title of the object

Mechanical biological treatment of waste.

Motivation

Reduction of greenhouse gas emissions.

Practice

Established technique.

Comment

The capacity of the MTB plant is 60,000 tonnes of waste per year. Production of > 50% of RDF, and bio-waste to an anaerobic digestion plant with the capacity of 20,000 tonnes per year.

Position in the present BREF

Pos. 2.2.2.

8.4.2 Objects in BREF – Emerging techniques**REnescience, Denmark****Reference plant**

REnescience, Denmark
Amagerforbrænding
Kraftværksvej 31
DK-2300 København
Tel +45 3268 9300
amfor@amfor.dk
www.amfor.dk

Title of the object

Utilisation of unsorted household waste for production of biogas, bio-ethanol etc. and reclamation of recyclable materials such as metals, glass and plastic.

Motivation

Reduction of CO₂ emissions.

Practice

Emerging technique.

Comment

Plant design is ongoing.

Position in the present BREF

Pos. 2.2.1 and 2.5.2.5 (currently only vegetable waste).

SCF Technologies, Denmark

Reference plant

SCF Technologies A/S, Denmark
Smedeholm 13B
DK-2730 Herlev
Tel +45 8830 3200
Fax +45 8830 3211
info@scf-technologies.com
www.scf-technologies.com

Title of the object

Production of “green” oils based on sewage sludge.

Motivation

Reduction of CO₂ emissions.

Practice

Emerging technique.

Comment

The patented CatLiq process is used to produce a “green” crude oil which can be used for heating purposes or further processed into fuel. The process is able to treat wet sludge with water contents above 50%.

Position in the present BREF

Pos. 2.5.2.5 (currently only vegetable waste).

Inbicon A/S, Denmark

Reference plant

Inbicon A/S, Denmark
Kraftværksvej 53, Skærbæk
DK-7000 Fredericia
Tel +45 9955 0700
info@inbicon.com
www.inbicon.com

Title of the object

Production of second generation bio ethanol based on agricultural remnants such as straw, garden waste etc.

Motivation

Reduction of CO₂ emissions.

Practice

Emerging technique.

Comment

Apart from bio ethanol also lignin bio pills will be produced to be used as a fuel in power plants. A pilot facility is under construction.

Position in the present BREF

Pos. 2.5.2.5.

Ekoport Oy, Finland**Reference plant**

Ekoport Oy, Keilasatama 5,
02150 Espoo, Finland
Tel +358 207 571 750
Fax +358 207 571 759
www.ekoport.fi

Title of the object

The production of diesel oil from REF feedstock by using the KDV technology.

Motivation

Reduction of the use of fossil fuels which leads to less CO₂ emissions.

Practice

Emerging technique

Comment

Plant capacity is approx. 11,000 tonnes/y of REF to produce 5 million litres/y of diesel oil. Plant is under construction and start-up.

Position in the present BREF

Pos. 2.5.2

8.5 Treatment operations for disposal

8.5.1 *Objects in BREF – Established techniques*

Ragnsells Heljestorp AB, Sweden

Reference plant

Ragnsells Heljestorp AB
Heljestorp 150
462 73 Vänersborg
www.ragnsells.se

Title of the object

Optical classification of waste

Motivation

Easy for both consumers and waste company.

Practice

Established technique

Comment

Effective classification of incoming waste into organic and inorganic waste fraction by differently coloured plastic bags.

Position in the present BREF

Pos. 2.1.9

8.5.2 *Objects in BREF – Emerging techniques*

Smedlund Miljösystem AB, Sverige

Reference plant

Smedlund miljösystem AB
Nya Varvet 97
426 71 Göteborg
www.smedlund.se

Title of the object

Dry conservation of organic waste.

Motivation

Environment-friendly technology with less need for transportation. It gives up to 30% more energy yield (methane) at the biogas plant.

Comment

Dry conservation is a careful, natural and energy efficient process that reduces the waste transportation need from 52 to about 2 times per year.

Position in the present BREF.

Not included.

9. Appendix 2 – Working Procedures in the Project

The working procedures in the project are as follows:

- Agreement negotiation between representatives of the Nordic BAT-group and representatives of Ramboll in order to obtain:
 - Agreement on the main objectives of the project
 - Acceptance of the consultant's proposal for collection of information on objects in the Nordic countries
 - Agreement on the content of the report
 - Agreement on the final activity and time schedule and the intermediate timing of tasks
- Selection of the objects in each of the Nordic countries
- Collection of BAT information from each object
- Description of BAT information from each object
- Evaluation of objects and simultaneous discussions with the Nordic BAT-group
- Progress Report start of January 2011
- First intermediate report mid February 2011
- First meeting between the representatives of the Nordic BAT-group and representatives of the Ramboll Group end February 2011 in Copenhagen, Denmark for discussions of the First intermediate report and the background material
- Draft final report for the project mid May 2011
- Second meeting of the Nordic BAT-group start of September 2011 in Copenhagen, Denmark for discussions of the final report
- Final report for the project mid September 2011
- Project evaluation held by phone/video meeting end September 2011

During the entire project the consultants are to cooperate in each country with

- Nordic BAT-group
- National representatives of the Waste Treatment Industries
- Authorities for Integrated Pollution Prevention and Control (IPPC)
- Associations for Waste Treatment Industries

Examples of progressive technologies and practices in Nordic Waste Treatment Industries

Rapporten beskriver nyere gode teknologier til behandling af affald (BAT) på anlæg og virksomheder i de nordiske lande med henblik på at blive medtaget ved den forestående opdatering og supplering af EU's reference dokument (BREF) omhandlende de bedste tilgængelige teknologier (BAT) for affaldsbehandling.

Ved udvælgelsen og præsentation af nyere teknologier er der lagt vægt på at de udgør et bredt udsnit af såvel teknologier som er i anvendelse på anlæg i de nordiske lande eller teknologier som er under udvikling og afprøvning. Af de 57 beskrevne behandlingsanlæg udgør de 49 anlæg og virksomheder der er i almindelig drift og 8 anlæg og virksomheder der er under udvikling med henblik på at komme i kommerciel drift.

De udvalgte anlæg og virksomheder er nærmere beskrevet i rapporten på grundlag af oplysninger fra virksomhederne selv og deres tilsynsmyndigheder.